UNIVERSITY OF TWENTE.

Faculty of Electrical Engineering, Mathematics & Computer Science

From Personal Knowledge to Community Knowledge: Stimulating Knowledge Sharing among Student Groups in Knowledge Management Platforms through Interaction Design

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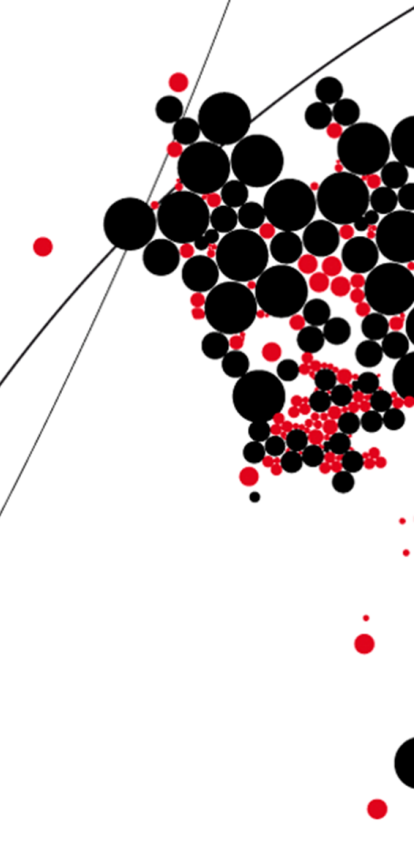

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Abstract

With the recent growth in popularity of collaborative cloud workspaces, there has also been a rise in popularity of community-oriented Knowledge Management Platforms. These services help users gather, represent, store and redistribute information for a range of purposes as a group. In the case of shared academic workspaces aimed at students, however, this collaborative potential has not fully materialized, with knowledge sharing most times being ad hoc and surface-level in nature and occurring in sub-optimal channels. In this paper, I ascertain students' main deterring factors and bottlenecks in the adoption of shared Knowledge Management Platforms through a set of exploratory one-on-one interviews, as well as their main expectations and use cases for participating in a student-oriented Knowledge Management Platform. I validate and quantify the findings of these interviews through an opinion survey with a larger student sample. Afterwards, by employing techniques from the Persuasive Technology field, I propose an interaction-based framework that can be used to tackle the identified pitfalls in a hypothetical shared Knowledge Management Platform through a more context-aware interaction design. Lastly, as a case study and to illustrate the theorized framework, I implement the proposed techniques to the case of Remnote, a Personal Knowledge Management Platform with intentions of transitioning to a more community-oriented business model.

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Contents

List of acronyms

HCI *Human-Computer Interaction*

HEI Higher Education Institution

ICT *Information and Communication Technology*

IQR Interquartile Range

KB *Knowledge Base*

KM *Knowledge Management*

KMP *Knowledge Management Platform*

PKM *Personal Knowledge Management*

SKM *Social Knowledge Management*

SaaS Software as a Service

UX *User Experience*

Chapter 1

Introduction

Knowledge Management (KM) is a discipline which studies how ”knowledge” is acquired, stored, transformed and distributed [1]. The integration of KM in various fields, such as academia and business, has been fostered by the promotion of *Information and Communication Technology* (ICT) [2]. *Knowledge Management Platform*s (KMPs) are, in turn, digital services that assist with knowledge management. An effective KMP creates a single, unified pool of information that can be easily accessed, traversed and updated [3]. With the recent growth in popularity of collaborative cloud workspaces (Google Drive and Microsoft OneDrive being the most widely used), the possibility of a group of individuals having a shared space to store, access and share knowledge has become more accessible than ever. These platforms can be accessed, used as reference and even edited by all members of these workspaces.

In academic settings, these systems can be particularly useful, since, if implemented and used efficiently, KMPs can lead to improved learning, better research, innovation, exposure to additional learning opportunities and skill development [4]. For higher education students, particularly, there is evidence that suggests that the usage of KMPs positively affects students' academic performance [5]. This effect is further amplified when these platforms are equipped with a social component, as it has been shown that, for students, peers are often one of their primary source of academic information [6]. Examples of these social components can be discussion forums, collaborative workspaces and communities inside the application.

Not many existing works look into the phenomenon of KM inside Higher Education Institutions (HEIs), however. Perhaps the most relevant recent work in this topic is Jain et al.'s [5]. After a preliminary literature review, they conclude that there is a research gap when it comes to the impact of KM in students of these institutions. They subsequently perform a study that tries to bridge this research gap, and gauges the impact of KM systems on HEI student performance.

The results highlight the positive impact of ICT-based KM systems on academic performance.

While literature tells us that it is clear that an effective KM strategy is invaluable for the performance of corporations and a few limited sources make the same assertion for the academic world, there is no notable research about how to encourage HEI students to adopt KM tools. This is the research gap that this paper will try to fill, doing so from the angle of Interaction Design.

Parallel to the lack of literature on it, and despite the evidence in favor of its usage, the concept of collaborative KM does not seem to have significant traction among HEI students [7]. Additionally, the synergy between KM through ad-hoc services and the social aspect of higher education is not explored by any of the most popular KMPs. For KMPs that want to cater to the higher-education student demographic, it is important to understand the root causes of this phenomenon by consulting the students themselves and detecting what the major bottlenecks in mass adoption of this system are, and transform these difficulties and requirements into features to cultivate an engaged audience.

This paper does exactly that. Through extensive User Research, the root deterrents and barriers that stop students from explicitly managing their knowledge are detected. Insights gathered from this user research are then distilled into a framework that describes how, through Interaction Design potentiated by techniques from Persuasive Technology, a KMP can alleviate pains and maximize gains for this user segment. The aim of this framework is to provide current solutions with the toolset to be able to adapt their product and engage with their target audience more effectively and convincingly. As an additional output of this paper, the novel concept of *Social Knowledge Management*s (SKMs) is coined to capture a system in which users can store, organize and collaborate around information as a community outside of a corporate setting.

Chapter 2

Report

2.1 Research Questions

The questions that this research will aim to answer are the following:

- **RQ1:** What are the main uses and expectations of higher education students with respect to KMPs?
- **RQ2:** What enables and deters students from engaging with the collaborative aspects of the main KMPs?
- **RQ3:** How can an application be designed to encourage students to participate in a shared *Knowledge Base* (KB)?

2.2 Related Work

2.2.1 Personal Knowledge Management in academic contexts

Jain et al. [5] perform an exhaustive review of the existing literature regarding KM in educational contexts, and more precisely in HEIs. They conclude that most of the existing literature revolves around the impact of KM on corporate performance, but little is known about its impact on educational institutions. Additionally, they conduct a study that gauges the impact of KM systems on student performance. The results highlight the positive impact of ICT-based KM systems on performance. However, the study is quite limited in scope and its sample population is limited to individuals from one university, which creates a potential sociocultural bias in the results, preventing the results from being generalizable. One valuable factor that is discussed in this paper is the different sections of KM, which are highly cited in the literature and are used as dimensions to gauge the

correlation between a solid KM strategy and students' academic performance. These are:

- *Knowledge Creation*: Addition or building of new components to the existing KB. Knowledge can materialize as individuals' process data and information based on their understanding and experiences. Some Knowledge creation techniques are higher-order thinking, group interaction, research and development and the "learning by doing" technique.

- *Knowledge Transfer*: Exchange of ideas, facts, learnings and experiences from one individual to another within our outside a group. This transfer entails more than just communication, as it requires not only a channel (physical or virtual) but also a bidirectional will to share and an intent to mutually benefit through increased understanding.

- *Knowledge Storage*: Establishment and maintenance of a KB which can be accessed when needed. Captured and stored knowledge is the cornerstone of KM, as without it all generated information is bound to get lost.

- *Knowledge Culture*: Set of norms, values and shared understanding among individuals in an organization regarding knowledge. An organizational lifestyle which enables and leads individuals to create, share and use knowledge with the purpose of organization and continuous success. This culture, while intangible, is reflected by the practices a group adopts, aspires and appreciates, and cultivating a KM culture can help a group create successful routines and stay up to date. Culture can be instilled by techniques like continuous positive reinforcement and members' involvement.

- *ICT*: In education, the barriers between man and machine are blurring over time with the advent of EdTech (Education Technology) and new ways of teaching, learning and managing knowledge. This, however, is an emerging phenomenon, whose effects on education are still being studied as of today.

These dimensions can be an interesting scope from which to approach the potential problems and struggles that are encountered by students when collaborating amongst each other.

Muqadas et al. [8] explore the challenges, trends and issues for knowledge sharing among employees in public sector universities. A total of 200 employees from four public sector universities in Pakistan were surveyed. The findings revealed that the main challenges to knowledge sharing were lack of time, lack of trust, lack of motivation, and lack of knowledge. The main trends and issues for knowledge sharing were found to be the need for more effective communication,

the need for more training and development opportunities, and the need for more incentives to encourage employees to share knowledge. As is also the case with more orthodox corporate settings like the one described by Jalili [9], professional scientific research is usually a much more competitive field than education, and therefore we cannot automatically extrapolate those findings to our target group.

Al-Emran et al. [10] investigate students' perceptions towards the integration of knowledge management processes in their learning systems, and in particular in a mobile learning (M-learning) system. However, research and discussion on the topics relevant to this paper are mostly done in the frame of Mobile Learning, which diminishes its usefulness for the use case discussed in this paper.

Ferrero de Lucas et al. [2] analyze the differences in *Personal Knowledge Management* (PKM) between Engineering and Teaching higher education students, and how popular ICT tools can aid in their overall KM processes. Results shed light on fundamental differences between the two groups with regard to their management and perception of KM. However, most of the tools discussed in this study (WhatsApp, email and Instagram, among others) are ones that are not explicitly designed and used for KM purposes, unlike the tools discussed in this paper.

Garner [11] theorizes that the (then) novel concept of Software as a Service (SaaS) could revolutionize the world of students' PKM. Although the conclusions are presented with future challenges (such as the necessity of Internet ubiquity), all of these roadblocks have already been solved in the present day. Furthermore, the article analyzes tools that were not explicitly designed with PKM or group KM in mind, but were used with that objective by a portion of its users. This is understandable since none of the tools that I consider in this article (which were designed with PKM in mind) existed at the time that the article was published.

All in all, the existing literature about this topic gives an enlightening insight into the possibilities of this field, but the environmental and implementational differences that are present between them and what this research paper aims to cover are too big to allow the direct application of findings of these works to this paper.

2.2.2 Explicit Encouragement of Knowledge Sharing

The literature in this topic is centered totally around corporate settings, and how managers can encourage their employees to share and pool their knowledge together to make processes more efficient. The concept of 'Knowledge Hiding' is used very often in this context, and it describes the practice by which employees of a corporation deliberately do not divulge knowledge to peers when asked for

it [12]. This phenomenon has various reasons behind it, but none can be applied in an environment that is not a corporate one.

Connelly et al. [12] discuss how an oil company used concepts such as gamification and nudge theory to encourage the exchange of knowledge between its employees. However, the dynamics inside of a company are much different than in a university, with the former being a much more competitive environment which encourages secrecy and withholding of knowledge. It is not illogical to think that the reasons for the two groups not engaging in Knowledge Sharing Services are not the same [9].

Tan [13] and Pascal [14] analyze how encouraged introductions of KM Services benefit corporations. While Tan looks at the acceptance and impact of KM on small and medium enterprises (SMEs), Pascal looks at the same phenomenon on bigger-scale corporations. The findings and recommendations of these papers, while insightful, cannot be extrapolated to students, though, because the two settings correspond to two different demographics with different motivations and perceptions of the problem [12]–[14].

As with Personal Knowledge Management in academic contexts, the literature in this area, while enlightening about its potential applications and implementation strategies, cannot be directly applied due to the insurmountable motivational differences between corporate and academic environments.

2.3 Theoretical Framework

The objective of this paper is devising a framework for KMPs to stimulate social activity within themselves by addressing the circumstances that deter this phenomenon from happening organically. For this reason, the following fields are used, and thus require a theoretical overview to be present in this paper:

- **Knowledge Management**: In order to have a concise concept of the reality of KM for HEI students, a clear theoretical baseline of this field is needed. Both the concept of KM and PKM, as well as an outline of the most popular PKM platforms are in the scope of this theoretical framework.
- **Persuasive Technology**: As stated in the Related Work section (Section 2.2), Persuasive Technology is a technique that has been extensively used in literature as a method to catalyze KM habits or scale their magnitude. Despite their established nature, it is important that this paper establishes a concise theoretical framing of this concept, because there are various moral considerations linked to the use of Persuasive Technologies that demand attention.

2.3.1 Knowledge Management

While there are numerous and very divergent definitions of the concept of knowledge, there is a consensus that it is an organized combination of ideas, rules, procedures and information [15]. Individuals have to extract meaning out of the information that they gather, and by doing so, that disorganized information becomes knowledge. It is only through meaning that information intersects with experience and becomes knowledge [16]. In the case of students, their learning process consists of gathering information and then generating knowledge based on their pre-existing knowledge. They constantly adjust their internal mental models as they transform information into knowledge [11].

Knowledge Management, as an explicit area of research, was born in the 1980s as a way to provide scientific rigor to the emerging theory that knowledge was one of the most important assets in groups and enterprises, and thus it had to be managed. Although implicit knowledge management has been done for as long as work has existed (and still is up to this day), its explicit management is a relatively recent phenomenon [17].

In simple terms, the role of KM is to build, transform, organize, deploy and use knowledge assets effectively. As such, Depres and Chauvel [18] define the typical event chain of KM as seen in Figure 2.1, in which the sections represent the following:

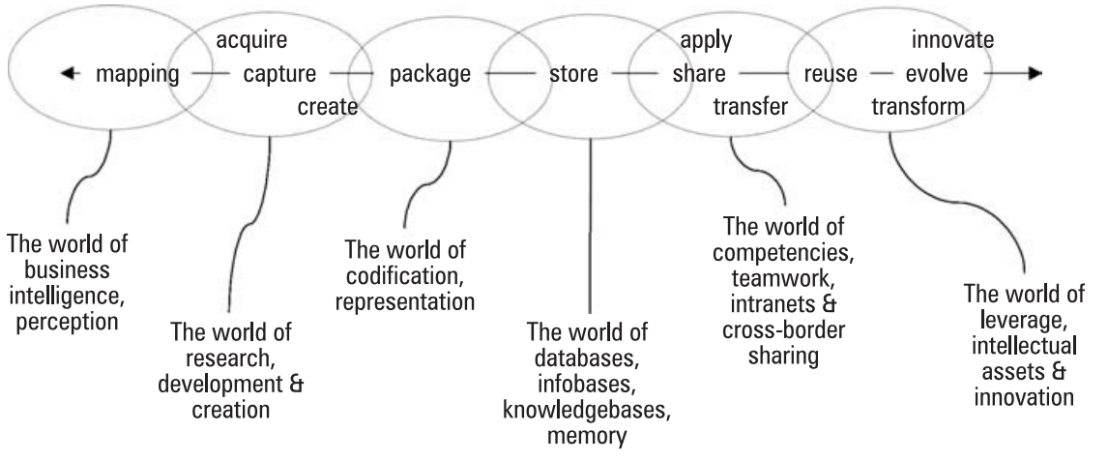


Figure 2.1: Knowledge Management Event Chain, as defined by [18]. While this diagram displays the phases in a linear fashion, the actual process is iterative and cyclical.

- *Mapping*: The origin of information is an important aspect of its management. Members of an organization are part of multiple environments of their own making, so each individual has multiple inputs of information that should be mapped.

- *Acquiring/Capturing/Creating*: From these environments, individuals appropriate information or combine elements that they deem valuable. There are feedback and feed-forward loops with this and the Mapping phase, since time plays an important part in information processing and individuals might find at a later point in time the information they needed earlier.

- *Packaging*: Tangibly speaking, this step involves the media in which the information is bundled by the individual. However, there are additional features to take into consideration, such as (perhaps even more importantly) the method of codification and representation. The individual infuses the raw information with meaning, codifies it and represents it on a medium. The nuance of semantics and communication play a big part in this role, since other individuals may extract different meanings from a representation than what the author originally meant.

- *Storing*: Individuals and groups store information in systems of all types. On an individual level, the brain could be considered a storage unit since it allows a person to store information and access it on demand in the future. Typically, however, KM deals with more tangible ways of storing and recovering information, such as file cabinets, libraries, or digital methods such as hard drives or cloud repositories. The bulk of the KM innovation effort is perhaps focused on this step of the event chain, mainly on reducing the friction of the user storing and later accessing information, usually by using the latest technological advancements.

- *Applying/Sharing/Transferring*: The value of knowledge can only be known through action and therefore should be communicated. The many interpretations of this fact comprise this section. Round tables, Knowledge Transfer processes and virtual team meetings are some examples of actions that exemplify this phenomenon.

- *Innovating/Evolving/Transforming*: This step of the chain closes the cycle. Knowledge must evolve at the same rate as information and environments change, otherwise it loses its value. To address this, companies start innovation programs and employ researchers who make sure that the organization is at the state of the art in all of its processes.

Personal Knowledge Management

Despite the bulk of the research on KM being centered around itself as an asset for corporations or aggrupations that consider knowledge as a monetizable

resource, this paper is instead geared towards PKM. This discipline can be considered a combination of the fields of KM and Personal Information Management [19], and has been found to improve individual competencies, as suggested by [20] and [21]. It is a conceptual framework to organize and integrate information that individuals feel is relevant to them so that it becomes part of their personal KB. It provides a strategy for transforming what might be random, fleeting pieces of information into something that can be systematically applied and that expands their personal knowledge. [22].

There is, however, a fundamental difference in objectives between KM and PKM, this being that, while KM is primarily concerned with managing organizational knowledge, the main objective of PKM is personal inquiry, namely ”the quest to find, connect, learn and explore” [23]. This is not trivial because the attitude of people towards KM, when performed individually and for a more personal purpose, completely shifts. This is mainly because the incentives, rewards and threats surrounding these two concepts are different (see Table 2.2). Due to these differences, the KM event chain discussed in the previous section is not exactly the same in PKM, but rather a more individual-centered derivation of it (see Table 2.1).

PKM Event Chain Phase	KM Event Chain Equivalent
Retrieving Information	Mapping, Acquiring
Evaluating/assessing Information	Mapping, Acquiring
Analysing Information	Creating, Packaging
Organising Information	Packaging
Securing Information	Storing
Presenting Information	Applying
Collaborating around Information	Innovating/Evolving/Transforming

Table 2.1: This table establishes a link between KM and PKM event chains as they are described by [18] and [23]. As it can be appreciated, the processes are similar, but the PKM event chain revolves around the individual more strongly.

Table 2.2 references the concept of *Social Knowledge Management* (SKM). This is a concept that this paper aims to introduce. It could be defined as an intersection of KM and PKM, in which the individual belongs to a KM community and works hand in hand with other individuals towards a shared KB which each member of the community can use as an enhanced PKM implementation.

	KM	PKM	SKM
Incentive	Prospect of recognition	Personal Convenience	Both
Rewards	Recognition inside group/corporation	Optimized information management	Both
Threats	Competition / losing edge	Non-existing	Competition / losing edge

Table 2.2: Differences in personal incentives, rewards and threats between KM, PKM and SKM. SKM, while compounding the incentives and benefits of PKM and communal KM, does not introduce new potential risks to the individual.

Personal Knowledge Management Platforms

Within the wide variety of Knowledge Management Systems, which are defined as technologies that enable effective and efficient Knowledge Management, we can find Knowledge Management Platforms, which are explicit digital software that perform the aforementioned function [24]. These platforms try to tackle one or more of the links in the KM event chain (see Figure 2.1). The KMPs that are discussed in this paper are ones that are mostly used in the world of PKM, although most of them can and are used as project knowledge management software as well. The most relevant platforms for this research (in terms of popularity and level of development) are described in Table 2.3, as well as the section of the KM event chain in which they participate.

	Retrieve	Evaluate	Analyse	Organise	Secure	Present	Collab
Notion	X	X	X	X	X	X	X
Roam	-	X	X	X	X	-	X
Obsidian	-	X	X	X	X	X	-
Anki	-	-	X	X	X	-	-
LogSeq	-	X	X	X	X	-	-
RemNote	-	X	X	X	X	-	-

Table 2.3: Most popular KMPs and their capabilities as seen from within the PKM event chain (although there exist plugins for some of these tools that afford them extended functionality, this table only accounts for officially released features).

2.3.2 Persuasive Technology

Gamification

Gamification is commonly defined as a process of enhancing services with motivational mechanisms with the objective of invoking gameful (game-like) experi-

ences and catalyzing other psychological and behavioral changes in non-game contexts [25], [26]. In simple terms, gamification aims to use game-like mechanics as extrinsic motivation to lay the groundwork for users to create habits and generate intrinsic motivation for a task.

The role of gamification is a topic of discussion among scholars. Hamari and Huotari [25] highlight the role of gamification in evoking the same psychological experiences as games generally do, whereas others like Deterding et al. [27] emphasize that the mechanisms implemented as part of gamification have to be similar as to those implemented in games, irregardless of the outcome. Nevertheless, a common process can be distilled from the literature, which can be seen in Figure 2.2. It compartmentalizes the process in a way in which the different gamification role theories are separated for clarity.

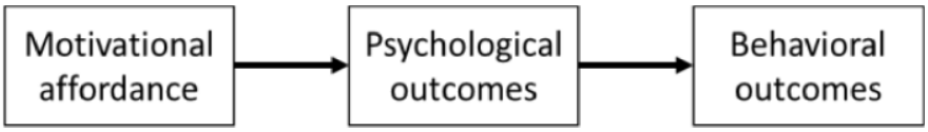


Figure 2.2: Gamification process, derived from [28]. Most academic studies introduce a Motivational Affordance and then measure the results in individuals' Psychological Outcomes and even longer-term Behavioral Outcomes.

Looking at this conceptualization, we can distinguish 3 distinct sections to gamification, all of which have a significant body of research related to them:

1. The implemented motivational affordances. This term ”affordances” is used in this context as the actionable properties between the system and the user, and refers to the properties of a system that can satisfy the user's needs.
2. The resulting psychological outcomes of these affordances.
3. The further behavioral outcomes that stem from the modified affordance-outcome loop.

Zhang [29] dives deeper into the concept of Motivational Affordances, reaching the conclusion that motivation has two main sources: Internal motives, like needs, cognitions and emotions; and external events (environmental incentives). Inside of the internal needs, which the paper describes as ”conditions within the individual that are essential and necessary for the maintenance of life and for the nurturance of growth and well-being”, Zhang claims that, in the world of ICT, the most relevant sources of motivation are a person's psychological, social, cognitive

and emotional needs. The author then applies these motivation sources to the world of design and describes the following directives when designing effective gamified systems:

1. *Supporting autonomy*: Defining autonomy as ”the psychological need to experience choice in the initiation and regulation of behavior”, environments which enable and support this usually result in developmental gains, engagement gains, performance gains and higher quality learning.

2. *Promoting creation and representation of self-identity*: ICT tools that want to engage its users should support the user's need for defining and representing itself. Letting the user choose how they want to express themselves and how they want to do things in distinctive ways.

3. *Designing for optimal challenge*: Riding on every user's intention of becoming competent, tuning the complexity of the tasks high enough to make the user feel challenged but low enough to not alienate them, their interest is effectively caught.

4. *Providing timely and positive feedback*: Individuals need to perceive or evaluate their performance towards goals. These goals can be established by themselves or by their environment. ”Timely” feedback means allow for the ”flow” of cognition and action does not get interrupted. ”Positive” feedback reframes critical insights into ones that reinforce behaviors that can take the individual closer to its goal.

5. *Facilitating human-human interaction*: Relatedness is a psychological need indicating the individual's intrinsic desire to belong. Interaction with others is the primary condition that involves relatedness, so perception of a social bond satisfies the need for relatedness.

6. *Representing human social bond*: Providing users with human-human interaction mechanisms via ICTs provides a condition for them to feel they are related, and providing ways of displaying the social bond (the extent, the intensity, the nature of the bond, etc) is a way to show the results of these interactions, thus reaffirming their feeling of being related and satisfying this need.

7. *Facilitating user's desire to influence others*: Power, in its essence, is a desire to make the physical and social world conform to one's personal image or plan for it. People high in the need for power desire to have impact, control or influence over another person, group or the world at large. They seek

to become (and stay) leaders. Leadership thus is a condition that involves and satisfies the need for power.

8. *Facilitating user's desire to be influenced by others*: Just as often, even those who have a strong need for power experience the desire to follow. Individuals seek, admire, and respect those who lead by providing followers with certain emotional feelings. Good gamified design should realize both leadership and followership needs to achieve a high motivational affordance.

9. *Inducing intended emotions via initial exposure to ICT*: Modern emotion theories propose that human beings have two synchronous systems that activate and regulate emotions. The primitive biological system has the evolution root of human beings and is an innate, spontaneous, physiological system that reacts involuntarily to emotional stimuli. The contemporary cognitive system is an experience-based system that reacts interpretatively and socially. The two systems influence each other and combined they provide a highly adaptive emotion mechanism. The key for applying emotional studies to ICT design is thus two-fold: induce intended emotions via the biological system that is invoked by initial exposure to ICT...

10. *Inducing intended emotions via intensive interaction with ICT*: ...and induce intended emotions via the cognitive system that is based on intensive cognitive activities. Sometimes, negative emotions may be desirable. For example, anxiety (negative) can be motivational in achieving certain goals (e.g. learning), and thus could be an intended emotion in ICT design.

Hamari et al. [28] perform a review of the existing literature and evaluate the effectiveness of different approaches using the three-section method that can be seen in Figure 2.2. The review concludes that gamification is effective in most use cases, but there are caveats. First, the performance indicators used to determine whether an implementation is effective are not standardized, and therefore authors usually create their own metrics. This can lead to indicators being biased to the nature of the study. Furthermore, they posit that the context in which gamification is implemented, as well as the nature of the test subjects themselves, are two extremely influential parameters that are often overlooked when conducting research. Lastly, another main distinction they find between the body of research is where in the process the results of the gamification are measured. There is some overlap in what outcome is measured, but while more than 90% of the analyzed works look at the behavioral outcomes of their implementation, only roughly half of them look also at the psychological outcomes. Although the results of these analyses indicate the effectiveness of gamification, having no insights into the

psychological processes taking place within the subjects provides no evidence that the behavioral habits generated are based solely on intrinsic motivation.

The field of *Human-Computer Interaction* (HCI) design has evolved greatly from its origins in accessibility to emotional and persuasive design [30]. In that scope, gamification in this field appeared as a new way to design for effective leisure and work systems. Marache-Francisco and Brangier [31] define gamification in the *User Experience* (UX) design context as ”an informal, umbrella term for the use of video game elements in non-gaming systems to improve user experience and user engagement”. When analyzed in the scope of HCI, the goal of gamification is to modify regular human-machine interactions and turn them into more engaging and motivating ones through the use of game elements in non-game contexts.

Nudge Theory

Nudge Theory is a branch of Behavioral Science that employs indirect suggestions and positive reinforcement as a way to influence the behavior and decision-making of individuals or groups, usually with economic purposes [32]. The key concept of this field, the so-called ”nudge”, was popularized by Thaler and Sunstein’s 2009 book *”Nudge: Improving Decisions About Health, Wealth, and Happiness”*, [33] but its origins can be traced back to last century in works such as Wilk’s 1999 ”*Mind, Nature and the Emerging Science of Change: An Introduction to Metamorphology*. A nudge is typically defined as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any option or significantly changing their economic incentive” [33]. Through nudges, knowledge from behavioral economics is leveraged to predict how people make decisions, and in particular how those decisions might deviate from rationality. With this knowledge, it studies ways to nudge these individuals into making the desired choices [34].

It is important to consider the ethical implications of the use of these nudges to avoid outright manipulation of the nudge receiver. Chammat and Giraud [37] analyze cases from Hansen and Jespersen’s four resulting quadrants and reach the following conclusions about the ethical aspects of each of them:

- Automatic Transparent: These nudges are centered around human reactions which occur independently of any kind of reflective thinking, and therefore do not completely respect the freedom of choice of the receiver. However, when paired with a transparent process, some authors consider that they can be made morally acceptable.

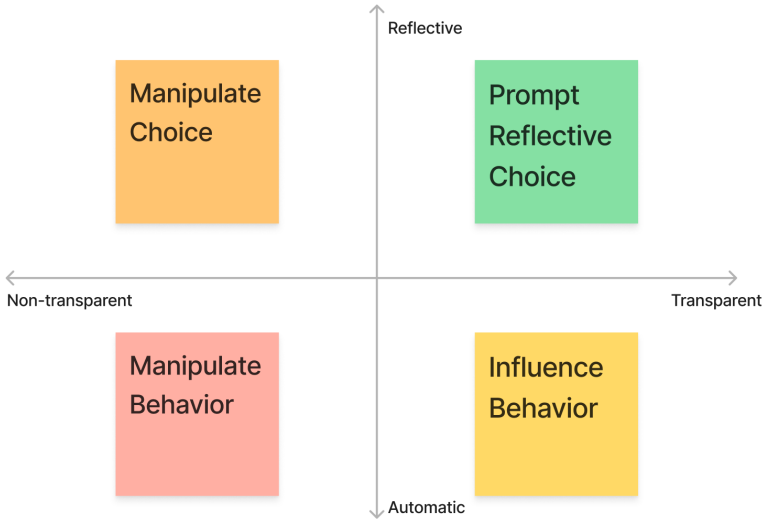


Figure 2.3: Hansen and Jespersen's nudge matrix and the role of nudges in each quadrant (adapted from [35] and [36]). The two dimensions represented are the mode of thinking the nudge engages in (automatic thought or reflective thought) and transparency of the nudge (whether the recipient of the nudge can reconstruct its intentions or the means through which it was executed).

- Automatic Non-Transparent: These nudges, since they operate under the receiver's perception and do not reveal themselves to them, are not morally acceptable.
- Reflective Transparent: These nudges are easy to spot, and can therefore be taken into account as a factor in reflective thoughts. In other words, they are truly respectful of individual freedom of choice and preferences. These are generally the least controversial nudges.
- Reflective Non-Transparent: These nudges are highly invasive. They unconsciously manipulate the reflective thinking processes of the nudged individuals. Because their influence is often not recognized, it is difficult for individuals to avoid them. Thus, they are not morally acceptable by most authors' standards.

In the field of Human-Computer Interaction, the concept of nudging was adopted on many fronts. Caraban et al. [38] perform a review of all the instances in the literature in which nudge theory has been integrated in this discipline and group them in 6 categories based on the purpose of the nudge used.

- *Facilitation:* Nudges that diminish the recipients' physical or mental effort by facilitating their decision making. While in theory they are designed to encourage recipients to pursue a set of actions that align with their intentions, the flow can be slightly modified to represent the nudger's interests without

alienating the recipient completely. Searching for an alternative to a choice that has been made by default is often considered slow, uncertain or costly by users [39]. This can be used to the nudger's advantage. An example of this is the modification of default options to suit the nudger's needs. For instance, Egebark and Ekstrom [40] replaced the default printer option to "print on both sides" and the use of paper was subsequently reduced by 15%. Furthermore, the researchers noticed a lasting change of attitude towards double-side printing long after the study, which further confirms the effectiveness of the nudge.

- *Confrontation:* Nudges that try to stop an action that is not desired by instilling doubt in the recipient. They attempt to stop mindless interaction and generate a reflective choice on the target. It has been shown that individuals make choices more carefully when they perceive a certain level of risk [41], so making targets aware of it can modify their choices. An example of this is giving users a reminder of the consequences of a certain action. For instance, Harbach et al. [42] carry out a redesign of the permissions information screen when downloading an application from the Google Play App Store. This redesign provides more concrete illustrations of the privileges that the user is giving to applications (for example, if the application is asking for permission to access the gallery, this implementation will choose pictures from the user's gallery at random and show them to the user with the prompt *"The application will be able to see and delete these pictures"*). This small change made the subjects more contemplative about this decision, as illustrated by an increased time spent in the permissions screen.

- *Deception:* Nudges that use deceitful techniques to change the perception of a choice on a user. One of the most striking examples in this category is the addition of inferior alternatives in order to boost the attractiveness of the choice desired by the nudger. As an example, Fasolo et al. [43] found that they could boost the sales of a laptop in an online store by displaying it next to a high quality laptop with a considerably higher price and a lower quality laptop with a comparable price.

- *Social Influence:* Nudges that take advantage of the knowledge that individuals want to conform to what society expects of them. Clear examples of this type of nudges are ones who exploit the spotlight effect, our tendency to overestimate the extent to which our actions and decisions are noticeable to others [44], which in turn promotes behaviors that elicit social approval

and avoid social rejection. For instance, electronic boards that publicly display car's speed on urban roads have been shown to cause a significant reduction of speed on cars that traverse that street [45].

- *Fear:* Nudges that evoke feelings of fear or uncertainty to push the user to make a desired choice or pursue a desired activity. One of the most common techniques in this group consists of giving users the perception that the alternative desired by the nudger is scarcer than it actually is, to appeal to the target's scarcity bias (their tendency to attribute more value to an object because they believe it will be more difficult to get in the future). For instance, Föbker [46] analyzes the effect of Limited Supply Scarcity and Limited Scarcity (two techniques used to infuse a sense of urgency and the popular Fear of Missing Out on the target) on customers of an online hotel reservation site, with confirmation on the hypothesis that purchase intention is positively affected by the introduction of either of these techniques.

- *Reinforcement:* Nudges that attempt to reinforce the desired behaviors by increasing their presence in the mind of the target. A prominent example of this kind of nudge can be seen on *Just-in-time prompts*. These prompts draw the target's attention to a certain behavior at appropriate times (usually when it deviates from the desired/ideal behavior) to instigate a change. For instance, KIA Motors [47] designed a system in its vehicles that alerts its drivers when they are deviating from eddicient/eco-friendly driving, and embedded it in the cars dashboard. They followed a sample of KIA drivers throughout 8 months and observed that this tool helped them create efficient driving habits in the long run.

For clarity, Figure 2.4 places the examples used in the sections above in Hansen and Jespersen's matrix.

2.4 Materials and Methods

The research, as mentioned in the introduction, consisted of three distinct sections: The preliminary, exploratory interviews; the broader, quantitative survey; and finally the creation of the interaction-based framework that implements the findings of the previous two steps with the reviewed Persuasive Technology concepts (Gamification and Nudge Theory).

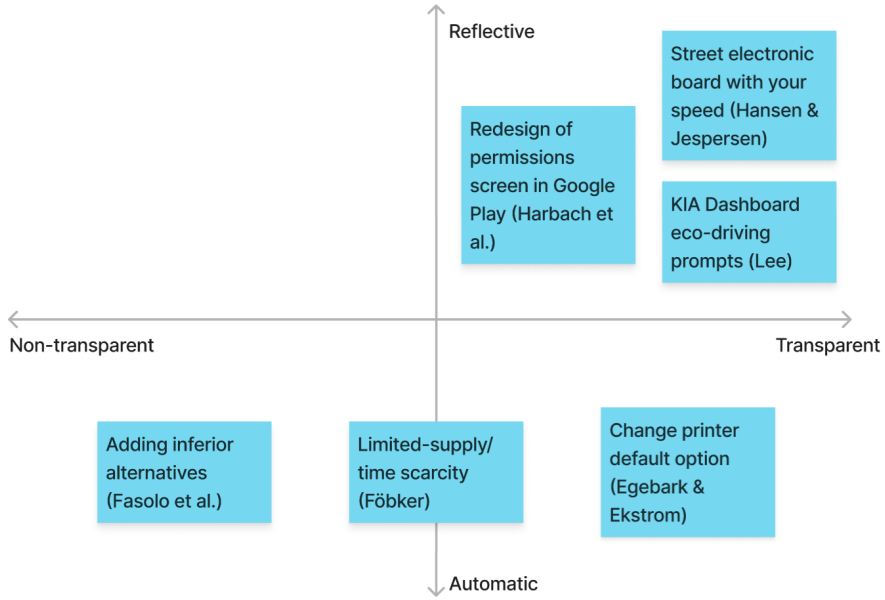


Figure 2.4: Discussed examples of types of nudges placed on the Transparent/ Reflective-Automatic matrix. As expected, the majority of the biggest examples are in the Transparent side of the matrix, seeing as Non-transparent nudges are academically not considered ethical.

2.4.1 Exploratory Interviews

Through a series of extensive, semi-structured interviews, the aim of this section was to discover the main incentives and deterrents of students when deciding to engage with KMPs and, in particular, with the collaborative aspect of these platforms.

Sample

The sample size for this interview was of 20 individuals. The participants were divided in two groups, with the main dividing factor being the degree of experience with KMPs. Out of these 20 subjects, 10 of them were individuals who currently used or had used these kinds of platforms in the past. With these participants, the focus of the interview was to discover what their routine and main pain points were with their preferred tool, as well as to gauge their degree of involvement with the social aspects of these tools. For the remaining group (10 participants who had never used KMPs) the interview focused on their experience with alternative, more implicit KM processes and the expectations of these potential users regarding explicit KMPs and its implications for community learning.

The degree of experience with KMPs, however, was not the only factor considered to choose the interviewees. To properly define the specific segments of the HEI student population that were desired for the interviews, two user personas

(Figures 2.5 and 2.6) were defined. The interviews intended to capture different experiences and approaches to KM, so the personas were intentionally designed to not be restrictive with those circumstances.

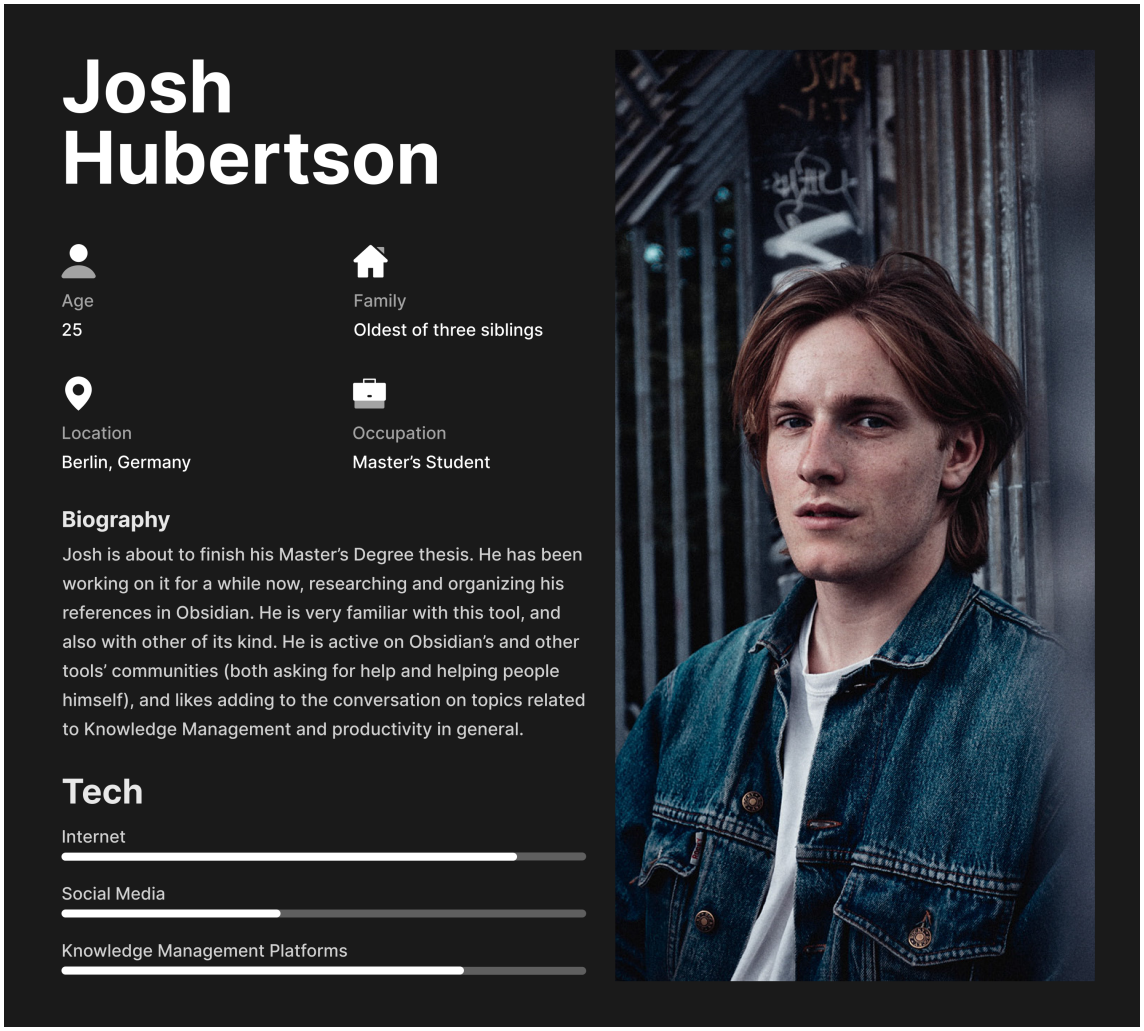


Figure 2.5: One of the two personas created for the Exploratory Interviews. These personas were defined as a reference for one of the two groups defined for the interviews. Namely, this persona encapsulates the individuals with experience in KMPs.

Research Instrument

For the screener interviews, Google Forms [48] was used. The interviews were carried out digitally, using video conferencing tools, namely Google Meet [49] and Zoom [50]. The audio of the interviews was recorded and then transcribed for analysis. The transcriptions were coded following the thematic coding procedures described in Blandford et al.'s *Qualitative HCI Research: Going Behind the Scenes* [51], and were executed with the help of Jason Chin's "Highlight Tool" [52]. The clusterization and visualization of the results was created in FigJam [53].

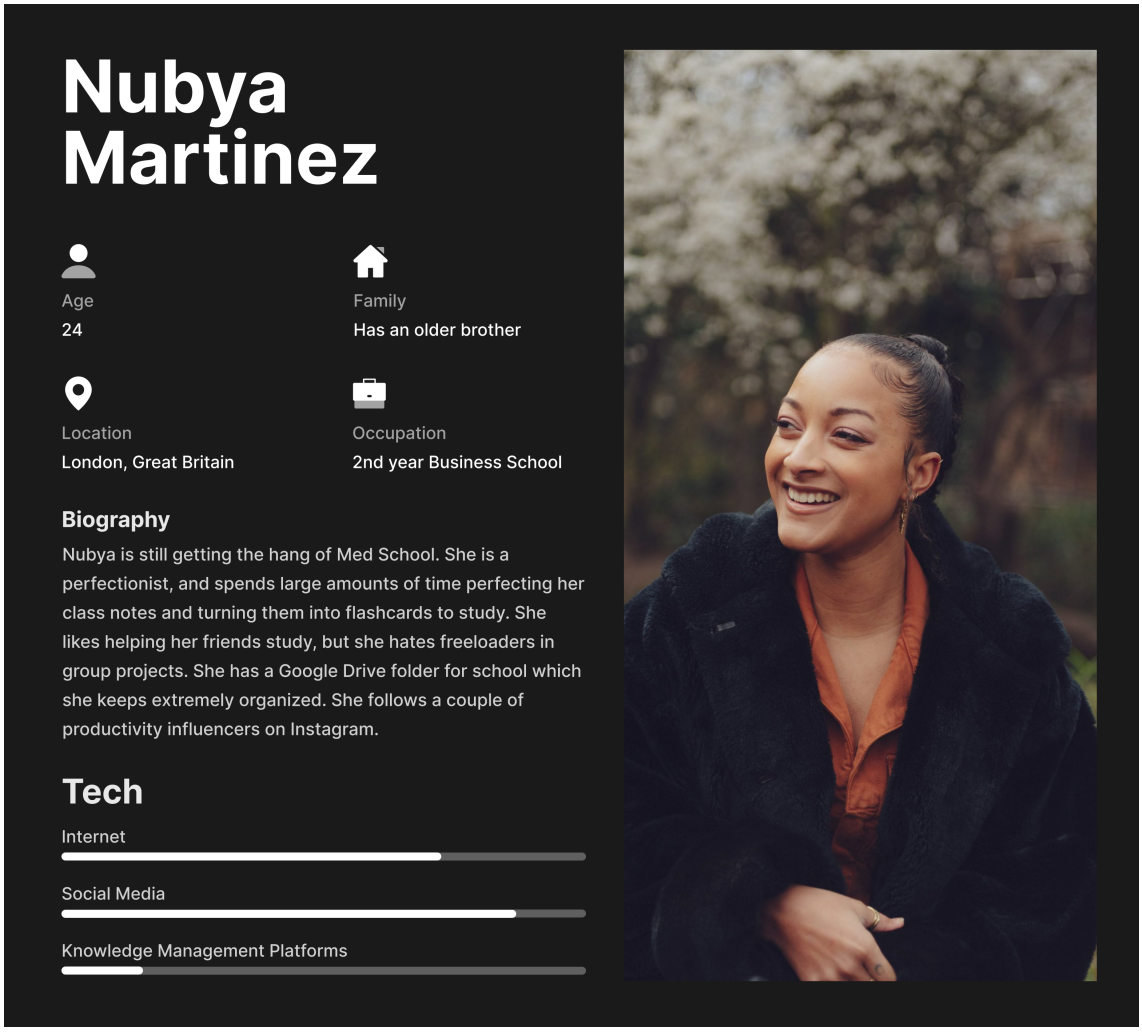


Figure 2.6: The other of the two personas defined for the Exploratory Interviews. This persona encapsulates the individuals with no experience in KMPs.

Procedure

In order to obtain a sample that was consistent with the desired personas, a screener survey was created. This survey had the function of filtering a large number of potential interviewees and obtaining a relevant and insightful sample of participants that was concordant to the personas defined. The screener survey questions can be found in the Appendix (Section A.1.1). The screener survey was distributed in university student online groups and online PKM communities alike.

As for the actual exploratory interviews, these were executed in a semi-structured manner. Both the structure and the methodology employed in the interviewing process was extracted from Portigal's 2013 book *"Interviewing users: how to uncover compelling insights"* [54]. These digitally executed face-to-face interviews were conducted with the participants of the screener survey that were deemed compatible with the characteristics specified in the user personas. The best

matching screener survey respondents were contacted by email about the opportunity to carry out these interviews. They were promised a 20€ (or national currency equivalent) digital gift card of their choice as an incentive for their participation.

The base script used in these interviews, which contained potential starting points for lines of questioning, can also be found in the Appendix (Section A.1.2).

2.4.2 Quantitative Survey

To avoid arriving to generalized conclusions just from an interview phase with a relatively small sample, a quantitative survey with a larger student sample was performed, which gauged how commonplace the ideas and concerns extracted from the in-depth interviews were. The objective of this survey was to quantify the qualitative insights of the previous step. However, there was also a space allocated for respondents to add additional insights that had not been prompted, to prevent biases from the Preliminary Interviews to carry over to this step.

Sample

Through inquiry in dedicated PKM forums and in regular HEI student groups, 140 participants were recruited for this survey. A giveaway of a 20€ digital gift card was advertised and then conducted in order to attract more participants.

The aim was be to obtain a representative sample of individuals according to the results of the Preliminary Interviews. This entailed a spread between KMP users and non-KMP users, as highlighted by the initial personas, but also a spread in other clusterizations that were devised during the Preliminary Interviews.

Research Instrument

The tool used for the creation, distribution and analysis of the quantitative survey was Google Forms [55]. It was chosen over other surveying tools because of its flexibility with regard to the creation of survey questions, its capability to easily export results for outside analysis, and the familiarity of the author with the tool. Microsoft Excel [56] was used to statistically analyze the results and arrive to data-based conclusions.

A Likert Scale [57] was used to quantify the answers. This scale, widely used as a tool to scale responses on survey-based research, has respondents specify their level of agreement (or disagreement) with a series of statements. Through this method, the intensity of the respondent's feelings towards a given item is

captured, and not only a discrete agreement/disagreement. Evidence [58] suggests that a 7-point rating scale, with a neutral option, 3 negative and 3 positive options with ascending intensity, is the setting that best optimizes the Likert scale system. For this reason, the rating scale in the survey was prepared in this manner. It is generally considered a bad practice to limit the analysis to just taking the average of the numeral values of the levels of the scale, as this assumes that the perceived distances between the qualitative labels of the values (”Completely disagree” to ”Completely agree”, for example) are constant as the numbers that represent them (1 to 7), which is not always the case [59]. The method that was employed to quantitatively analyze the data was instead the following:

1. For single indicators of the overall sentiment of participants in a specific item, the median and the mode were used. Using these instead of the numeric average prevents the aforementioned assumption from introducing bias in the analysis.

2. To get an idea of the polarization of the answers, the Interquartile Range (IQR) was used. This metric gives information about how spread out answers are by measuring the distance between the 25th and the 75th percentile.

3. The above metrics for each survey item for each quadrant were grouped, and the standard deviation was calculated on these groups to find how divergent the opinions expressed between quadrants were.

Procedure

The participants were initially classified in the clusters derived from the results of the exploratory interviews (see Results section) for ease of classification. Then, the participants were presented with the most popular statements from the one-on-one exploratory interviews, classified by the themes identified in the thematic analysis carried out for them. They were asked to indicate to what extent they identified and agreed with each of the statements.

A Table can be found in the Appendix (Section A.2.1) which shows the questions from the survey, as well as the median of the Likert scores assigned to that question by the defined subgroups (see Section 2.5.1 for more information about these subgroups).

2.4.3 Interaction-Based Framework

Based on the feedback given by students, a framework was crafted describing essential steps that a KM Service aimed at students should take to encourage knowledge sharing within their platform. This includes harnessing the potential of the expectations and ideas of the interviewed potential users while avoiding their biggest caveats and deterrents to the maximum possible extent.

Design Tools

The wireframes for the basic implementation of the discussed techniques were made with the Balsamiq wireframing tool [60]. This tool allows for rapid and flexible low fidelity prototyping, a powerful tool to convey concepts visually.

The main tool used for the design of the high-fidelity prototypes for the case study (see next section) was Figma [53]. This tool is immensely flexible, and allows for fast creation and iteration of high-fidelity prototypes.

Procedure

Based on the combination of the results obtained from the exploratory interviews and the quantitative survey, a series of pains and expectations were gathered surrounding digital collaboration by students. These requirements were then distilled into design specifications. Based on those specifications and for illustrative purposes, wireframes (visual guides that serve as low-fidelity prototypes and represent the skeletal framework of a website or app) were designed using the Balsamiq wireframing tool [60].

As a case study to shed light on the potential applications of this interaction framework, a set of higher-fidelity implementations of the low-fidelity wireframes were designed for Remnote [61], one of the previously analyzed KMPs and one of the most widely used ones by the participants of the Exploratory Interviews and the Qualitative Survey. These high-fidelity prototypes were made with Figma [53].

2.5 Results

2.5.1 Exploratory Interviews

Through these initial exploratory interviews, an initial impression of the appeal it has on the student demographic was obtained, as well as of the most common pitfalls of this concept. A basic classification of the target group into more nuanced segments was obtained. As it can be appreciated in Figure 2.7, out of the 201

participants that took the screener survey, 30 participants matched the desired profile and were thus contacted for follow-up research. Out of all the contacted individuals, 20 were willing to participate in the proposed qualitative interview.

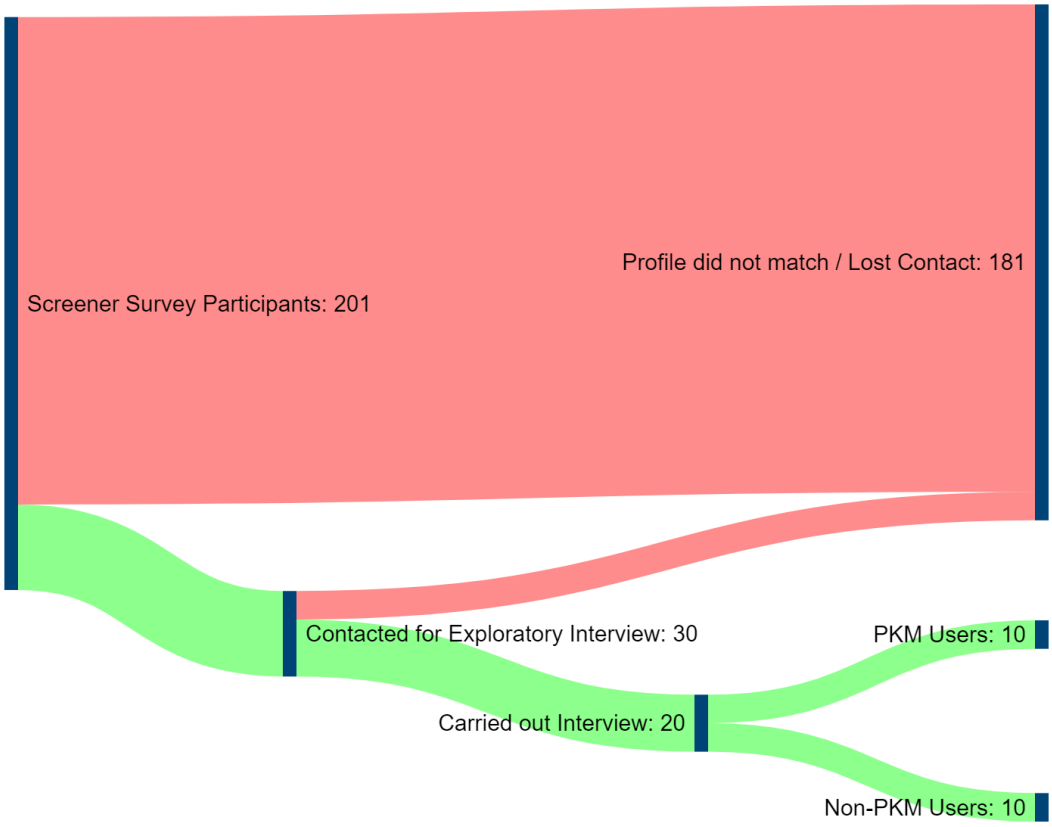


Figure 2.7: Sankey Diagram representing the amount of subjects that participated in the Screener Survey and the Exploratory Interview respectively. As it can be seen, only roughly 15% of screened participants fit one of the two defined personas, and two thirds of these selected individuals (10% of the total sample) was finally interviewed.

Through thematic coding, the most common themes were distilled from the transcriptions of the exploratory interviews. Figures 2.8 to 2.14 represent the most popular themes identified in the interviews, classified by thematic categories. The "+1" symbols on each of the items represent an interviewee who specifically mentioned it. The approach that was taken was that of *inductive coding*, meaning that the data is what shaped the codes, and there were not any predefined structures crafted before the analysis.

As it can be seen in the figures, a basic clustering that was obtained from this interview was a bi-dimensional one. The main distinction from the interviews (KMP users versus nonusers), which was confirmed to be an informative distinctive, was inherited as a clustering dimension. Additionally, an additional clusteri-

zation was observed when analyzing the interviews: There are very fundamental differences in the way that normal students and Student Researchers interact and structure their academic experience around these tools. Below are more precise definitions of what each of these two groups entails:

- Normal students: Students whose academic tasks are limited to learning/memorizing specific topics. They use KMPs (and other alternative services in the case of non-KMP users) to optimize their studying experience, retain concepts more effectively and permanently, and have a centralized KB in which to access all the necessary study material.
- Student researchers: Students who, either as part of their studies or independently of them, are conducting research. They use KMPs, among other things, as an academic reference manager to keep track of all the resources they use and what information they take from them.

The placement of the elements inside the matrix is not arbitrary. The elements were placed in the quadrant(s) of the group(s) that reported it. If more than one quadrant reported it, the item is placed in the line that divides the two (or more) quadrants to represent the commonality.

Figure 2.8 shows the most popular KMPs reported by interviewees. Tens of different platforms were talked about, but only ones with more than one distinct mention are shown in the figure.

While strictly not a KMP, the tool that was reported as being used by the most participants (60% of participants) is Google Drive. This tool, as it can be appreciated in the figure, is used by interviewees of all quadrants. Naturally, however, the use of this tool differs depending on where on the matrix the user is. While non-KMP users report that they use it as their main platform for collaborating and sharing resources with other students, KMP users tend to use it as a support tool while carrying out most of their workflow in another tool. One non-KMP student claims that ”It’s the platform that everyone knows and it allows for collaboration with little to no setup time”, indicating that users find value in the low deployment time of this tool, considering students’ relative familiarity with it. A student researcher that uses KMPs claims of Google Drive that their ”use for it is to quickly share and access files that other research team members want me to see or vice versa”. This is not an uncommon claim and highlights that Drive is seen as simply a file sharing platform for KMP users rather than a collaboration platform in of itself.

Both Anki and Remnote are exclusively used (for this sample) by normal, KMP using students. The main appeal of these tools seems to be centered around the

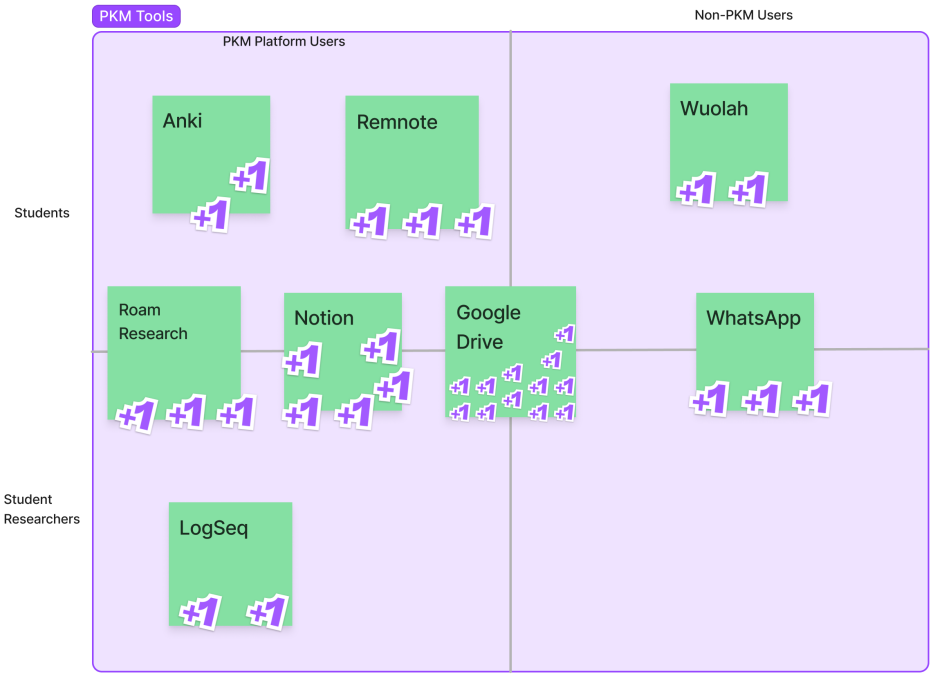


Figure 2.8: Most popular platforms among exploratory interview participants. Google Drive appears to be the most popular platform, appealing to all the quadrants. Notion is the most popular personal KMP according to the sampled population.

flashcard system that both tools have, which help students learn more efficiently for information-dense subjects. In fact, half of the subjects which reported using either of these two tools are Medical Students.

Out of all the KMPs (according to the definition used for this paper) that were reported to be used by participants, Notion was the most popular. Surprisingly, however, most people agreed that Notion was not their preferred platform to collaborate. Rather, they view Notion as a platform to publish finalized work and visualize it in an appealing way. Only 1 interviewee out of 5 Notion users claimed to use Notion daily to collaborate with peers simultaneously.

Interestingly, WhatsApp was reported as a Knowledge Sharing tool by some interviewees. Two interviewees said that they exchanged resources with their research peers through a Whatsapp group chat. They justified this by claiming that it is a platform which requires no onboarding period and has a non-existing learning curve (mainly because everyone in these groups was already familiar with WhatsApp or other instant messaging apps before).

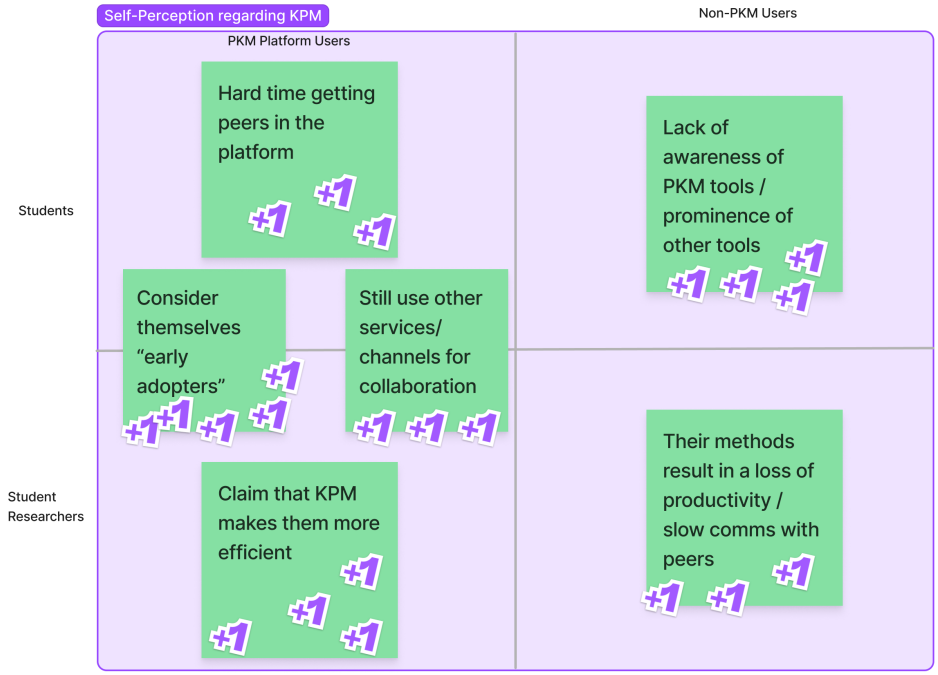


Figure 2.9: Commonly reported self-perceived experiences regarding Knowledge Management among exploratory interview participants. As it can be appreciated, the self-perception of being an "early adopter" is commonplace among the interviewed KMP users.

Figure 2.9 shows commonly reported self-perceived experiences regarding Knowledge Management among the interview participants.

As it can be appreciated, KMP users share a common conception about themselves, this being that they are early adopters. When asked to elaborate on this, subjects claimed that they are "always trying to improve my systems or approaches to doing things" or that "we tend to integrate working on activities with the latest technology, because you know, the word has gone digital. So we have to try to, you know, meet up with the requirements of this new landscape". This can tell us that KMPs are still perceived as being in an early stage of technological maturity, a stage which only attracts these so-called "Early Adopters", which are more open to trying out less established technologies or tools. This, however, is a relatively small group of individuals, so KMPs should focus on developing themselves to reach a stage of maturity suitable to the mass markets.

A relevant piece of feedback that some non-KMP users provide is that the reason why they have not used KMPs is because they were not even aware of their existence. This lack of awareness of these tools by students can be explained by

a lack of or weak go to market strategy by these platforms, or by the presence of very strong competitors in the form of digital workspaces by Google or Meta that, due to their pervasiveness in the technology world, stay on students' top of mind and become their tools of choice, even if they are not the most ideal or catered to their needs (see Google Drive or WhatsApp).

Three out of the four student researchers that do not use KMPs acknowledge that their collaboration methods were leading them to a sub-optimal productivity, mainly because of the latency in communication with their peers and because of the limitations imposed by their employed tools. However, as highlighted in Figure 2.10, it is not easy for this group to create a behavioral change among their peers.

On the other hand, the majority of KMP-using student researchers agree that using these tools has had a positive impact in their workflow. Some claim that it makes them more productive, and others claim that they are not certain about the productivity, but they acknowledge that KMPs have helped them establish connections between concepts that they would have not found with other tools.

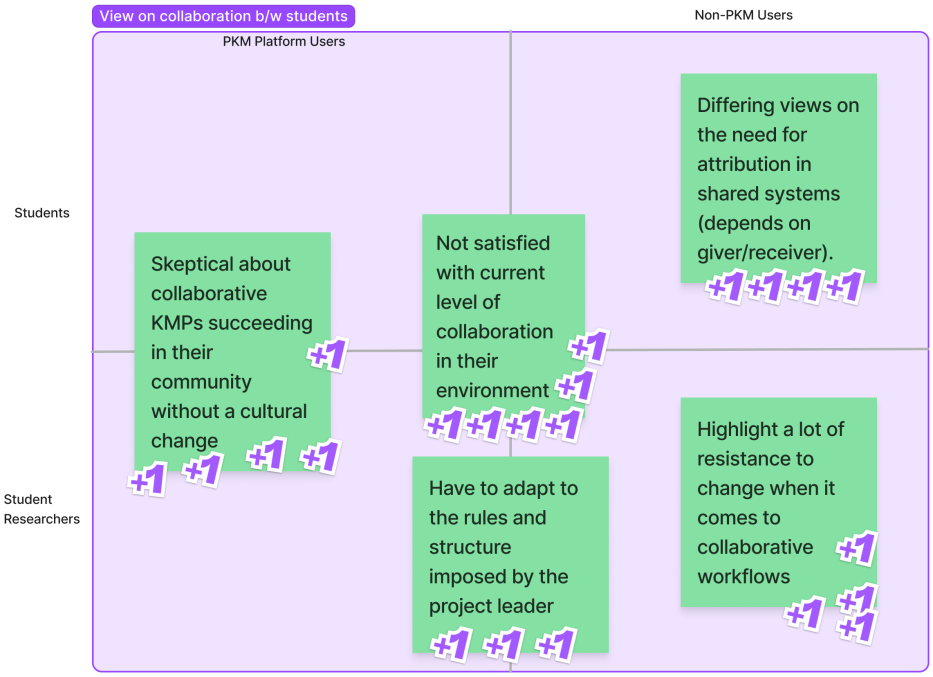


Figure 2.10: Commonly reported views on student collaboration among exploratory interview participants. Among the interview participants, there is an overall sentiment of dissatisfaction with the collaboration present in their immediate (academic) environment.

Figure 2.10 shows commonly reported views on student collaboration by the

subjects of the exploratory interviews.

The most common opinion expressed by members of all quadrants is that they are not satisfied with the level of collaboration that exists in their environment. While most students claim that they collaborate frequently with their immediate circle in their study or with group project partners, they claim that they often lack a feeling of community within their study as a whole and wish it was different. As for student researchers, their complaints are more geared towards the fluency of the collaboration with their research colleagues.

A different but relevant opinion expressed uniquely by non-KMP using students is that, in the hypothetical implementation of a community-based KMP, the concept of attribution would be a relevant point of discussion. Three of the four participants that brought this topic up in the interview saw the implementation of methods to keep track of individuals' contributions to a shared KB as necessary to encourage more contributions and discourage what some of them refer to as "leeches", students that would just access these KBs to extract resources and never make contributions themselves. One student claims: "I wouldn't mind sharing (academic resources, lecture notes) with my friends, who I know will help me back if I need it. But if I shared them with everyone and with people that I know haven't attended the lectures, who simply come in to take my notes and end up get the same grade as me, I don't know if I'd like that".

Figure 2.11 shows commonly reported details and methods of collaboration among exploratory interview participants.

A discouraging fact that non-KMP using students are almost unanimous about is that they almost never collaborate, either physically or digitally, with other students if it's not within a group project. One of them claims: "We never collaborate for exams. Everyone does their own thing. If we collaborate, it's always because we are in a group project". When they do collaborate, as made apparent by the interviews, it's only in very small groups, usually of friends inside their study. "I get on Discord with four or five friends, one person shares their screen and we all solve past exams together", says another interviewee.

An interesting tendency that the interviewed students, both KMP users and non-users, share is that they show interest in being in charge of creating the structure of the digital collaboration in a group work environment. However, the way the students frame it points to the conclusion that they mostly do not do it out of initiative and proactivity, but rather as a preemptive measure to not lose track of the structure. "I would rather create the structure myself than let any of my teammates make it. This way, I know where everything is", says an interviewee who frequently works collaboratively in Google Drive. "It's annoying to be unfamiliar

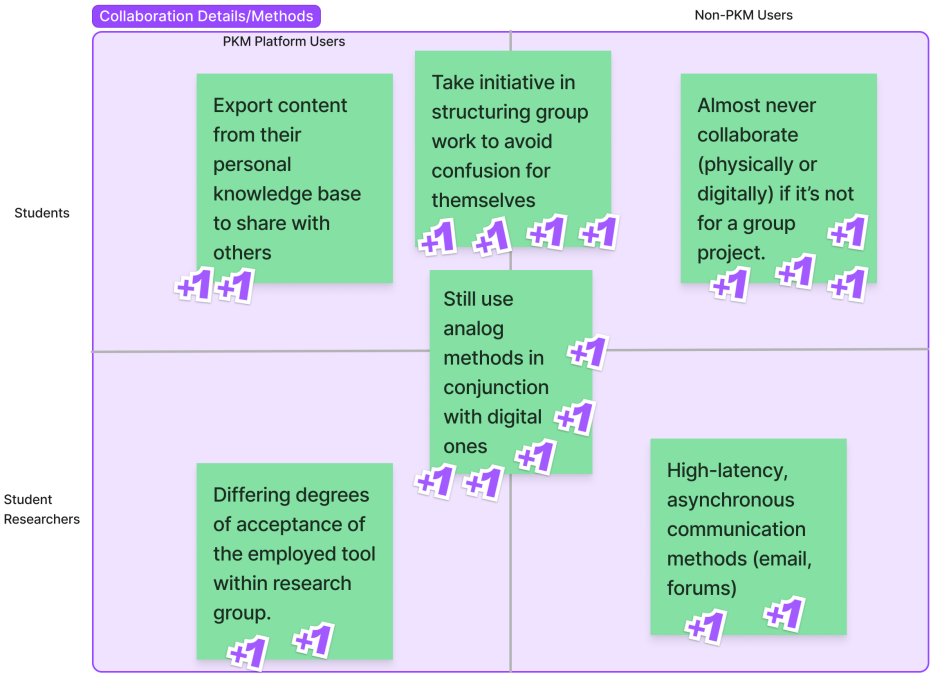


Figure 2.11: Commonly reported details and methods of collaboration among exploratory interview participants of different groups. Analog KM methods are still commonplace among the interviewed HEI students.

with a folder structure and waste time figuring out where a certain file is, and this doesn't happen if I just make the folder structure myself in the first place", says another student, who juggles their workflow between Notion and Google Drive.

A habit that most interview participants share is that, interestingly, they still have analog methods of PKM, which they combine with digital methods in differing ways. While the reasoning behind this differs from participant to participant, the most commonly reported reason is that some steps of the Knowledge Management process (usually capturing information from different sources) are performed faster analogically for some users. For example, an interviewee claims: "In my engineering classes, there is so much math I have to write down. This is much easier on paper. After class, I take pictures of the formulas and put them in my digital notes".

Figure 2.12 shows commonly reported uses for KMPs among interview participants. As it is to be expected, only KMP users had insights about these platforms, so that is the reason no responses appear on the right part of the feature.

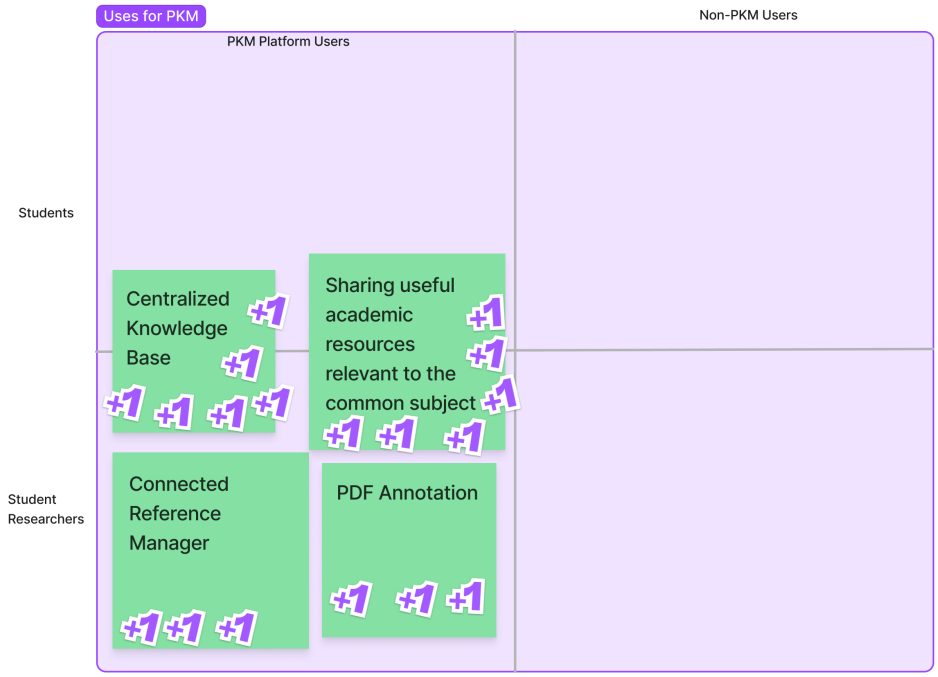


Figure 2.12: Commonly reported uses for KMPs among exploratory interview participants of different groups. The most popular use case for these platforms among students is to share academic resources of interest between them.

Naturally, the most popularly reported use for personal KMPs is their broad expected use: As a centralized knowledge base. A Notion user has this to say about his KB: ”It’s just a way of simplifying my job and helping me to keep up to date, to be current in my day to day activities. It has made everything easy for me. I kind of depend on it, but it is very reliable.” An interesting observation is that some people do not just use these platforms for academic purposes, but integrate their personal life in them as well, making them centralized twofold. ”What works for me is, Obsidian allows you to have different vaults, so I’m able to connect to different folders. That allows me to keep different things kind of separate, but together at the same time”, claims an Obsidian user.

Most of the student researchers who are familiar with KMPs also reported using these platforms as a tool to manage the references used in their current projects. When probed about the reason to use these platforms to manage their academic sources instead of actual Reference Managers (like Zotero [62] or Elsevier’s Mendeley [63]), the unanimous answer was that the participants like having all their resources centralized in one platform, rather than using individual spe-

cialized platforms for every single task. This is exemplified by the quote used of the Obsidian user in the paragraph above.

PDF annotation seems to also be popular among student researchers. In the words of one of them: ”I don’t use templates for my notes. I kind of just like, let’s say, highlight in the PDF reader, and work with those annotations. Maybe even export it as a markdown document, and then read those annotations, or maybe combine those annotations with my own notes. With this, instead of having to go back to the actual papers, I can just know that everything is in Remnote with my own twist to it.” It seems that individuals that go through large amounts of scientific publications as part of their research appreciate the heightened productivity generated by the integration between PDF annotation and their personal KB.

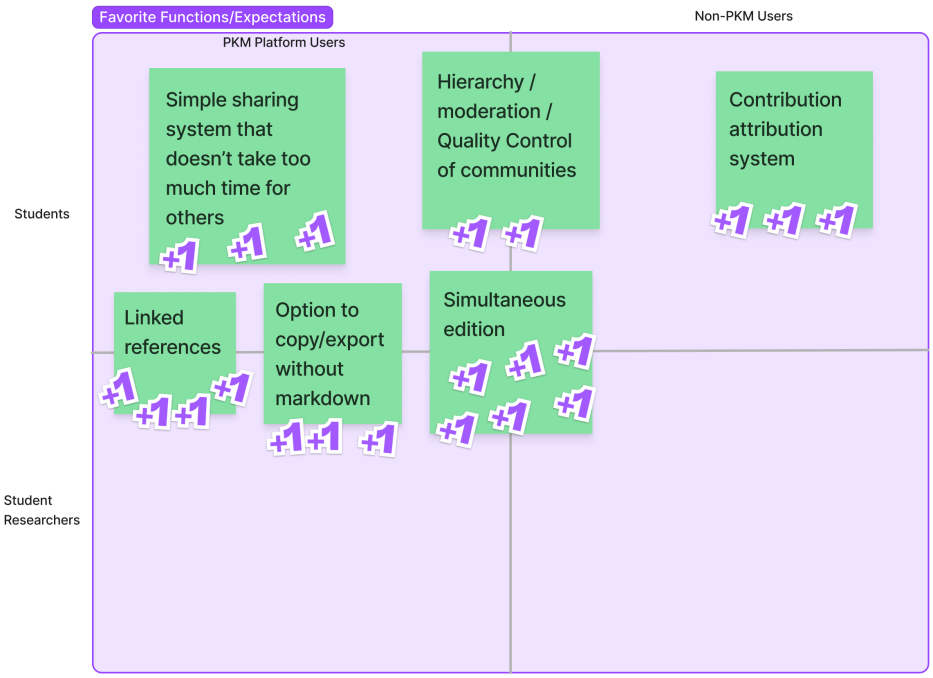


Figure 2.13: Commonly reported favorite platform features among exploratory interview participants of different groups. Simultaneous edition, while being an uncommon feature in KMPs, is one the most commonly reported favorite features of users.

Figure 2.13 shows what participants report as being their favorite functions in their current set of tools, and also what functions they would want in a different tool to tip them to switch to using it.

A function that is unanimously enjoyed among all quadrants is that of simulta-

neous edition. A Google Drive using participant says: ”It’s just so easy to collaborate on it. We could be together in a room or everyone at our own place, and we know that we can just get in a document and do our own thing”. Editing locally and then sending files to another person for them to edit is perceived as obsolete and inefficient by most interviewees. However, they claim that they are often bound to using a specific tool because a figure of authority in their environment (teacher for students, supervisor or research leader for student researchers) dictated that the tool had to be used for that context. ”Unfortunately, while personally I work with LogSeq, I still have to share my content through email and different shared drives, because my research leader just operates that way”, claims an interviewee, then adding: ”It definitely results in a loss of productivity. Part of it is I’m currently I’m not kind of leading any research projects except my dissertation. So I’m stuck kind of fitting in into other people’s processes”. The challenge remains for KMPs to facilitate the transition from older, more established tools.

Linked References are a function that is of vital importance for multiple interviewees. In fact, it was reported by two of them that this function was the main factor that convinced them to switch from other tools to KMPs. ”It’s such a nice feature, I’ve structured my research methodologies to it.”, claims a student working on their Master’s Thesis, ”Sometimes I’ll even set up the linked reference before having anything on them, and come back later to expand on them”.

As mentioned in Figure 2.10, some students would want a contribution attribution system to be in place in their ideal tool. They value rewarding a job well done academically and even punishing a job not done. An attribution method that tracks contributions would be a good encouragement for motivating overachieving students even more and discouraging the so-called ”leeches” from not benefiting from this initiative without contributing first.

Figure 2.14 shows commonly reported pain points of exploratory interview participants when using their respective tools.

A pain point shared by users of all quadrants is that the management of privacy settings for all their directories. Most interviewees work with multiple directories on their day to day, an these directories all each often complex substructures. It is reportedly challenging for them to manage who has permission to access all their directories and subdirectories, as well as the level and nature of this clearance. Two interviewees even mentioned how editing these permissions is an effort that they find annoying, even when it is at the start of a project and they are setting up the collaboration structure. ”In Google Drive, it’s really annoying to have to check who can edit what, who is actually editor or who can only view. It’s really annoying”, complains a student.

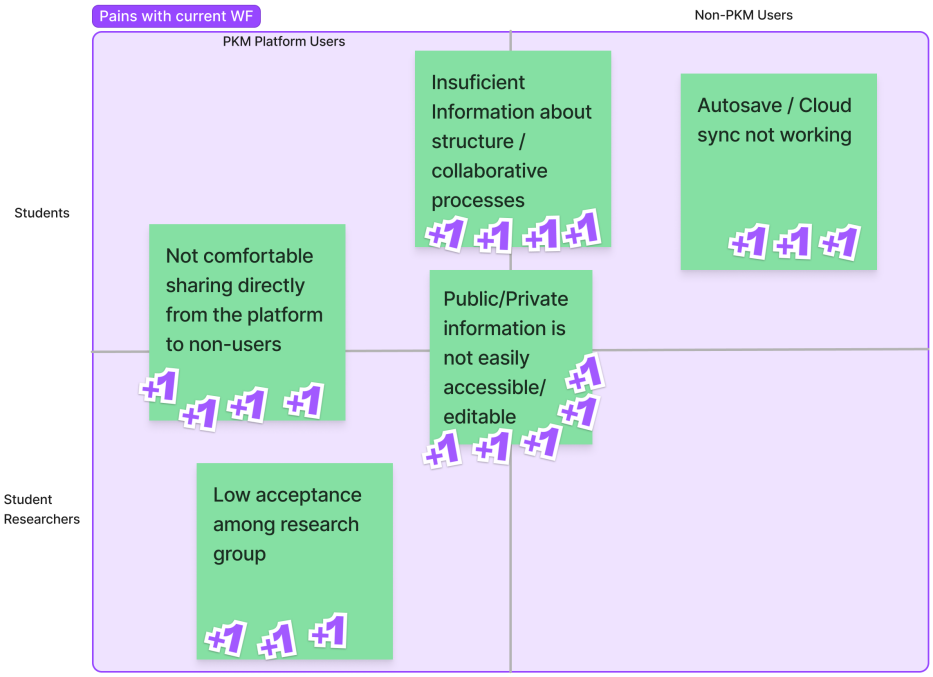


Figure 2.14: Commonly reported pains experienced in platforms among exploratory interview participants of different groups. Information about privacy not being easily accessible and editable is reported as a pain from all quadrants.

As mentioned in previous matrices, a lot of interview subjects do not feel comfortable with sharing content directly from the KMP they use to create this content. They report various barriers for this, that range from technical to social:

- Participants report being discouraged from sharing directly from these platforms due to the fact that getting other people that are ignorant about the inner-workings and technologies involved in the tool in question would require an onboarding process that represents an unwanted effort. ”I would rather just send my peers screenshots that have to explain to them how Notion works”, claims a student researcher.
- An additional discouraging element is that KMP users tend to structure their personal KB in a way that suits them, but is not necessarily the most understandable by other users. By giving others access to this file structure, interview subjects worry that they may be introducing an unwanted and unnecessary degree of complexity to the flow of information.
- Interviewees also complain that their peers’ resistance to trying other tools

is too high, and this stops them from adapting when they are exposed to content crafted in these platforms. ”I don’t want to make my supervisor’s life harder than it already is”, claims a student researcher, ”so I just export content and format it in Microsoft Word”.

2.5.2 Quantitative Survey

After discarding the entries made by non-students, the final sample of the quantitative survey was of 124 people. As mentioned in the Methods section, the respondents were classified at the start of the survey into one of the four quadrants that were derived from the results of the preliminary exploratory interview. As it can be appreciated in Figure 2.15, 19% of respondents were normal university students, while the other 81% of respondents were students that were conducting research as part of their studies. 63% of respondents were KMP users, versus 37% not knowing or having experienced these platforms in the past.

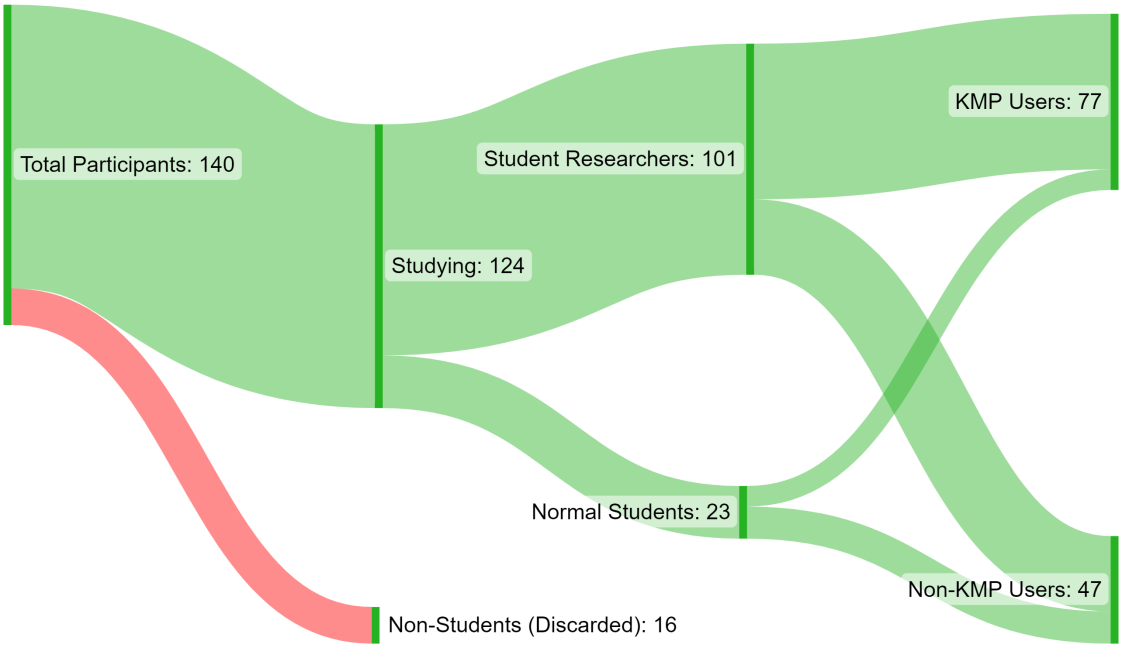


Figure 2.15: Sankey diagram depicting the spread between Student Researchers and Normal Students among the quantitative survey respondents, as well as the spread between KMP and non-KMP users.

Tables representing the results of the survey can be found in the Quantitative Survey section of the Appendix. Below is a list of the most noteworthy insights that were extracted from the results of the survey:

Uses for KMPs

- Overall, the participants seem to relate to the shown use cases for KMPs.
- KMP-using students report that their main use for KMPs is to maintain a Personal KB, whereas KMP-using student researchers report using these platforms more as a reference manager for their research.

Self perception towards PKM

- There is a large disparity of opinions expressed about the statement *"I have sometimes felt like the digital methods I have used to collaborate with peers have been responsible for a decrease in productivity of the whole team."*, mostly among KMP users (3 point median difference among the two quadrants in this group).

Views on collaboration

- Contrary to what the Exploratory Interview participants suggested, it seems that students of the four quadrants are moderately content with the level of collaboration that they perceive in their most immediate study environment.
- There are is a noticeable disparity in agreement between KMP-using participants on the statement *"My team members are usually very adamant about what digital tools to use when we work in a project. It is very hard to change their mind"*, with KMP-using student researchers agreeing substantially more (median = 5) than KMP-using students (median = 3).
- It seems, contrary to what the Exploratory Interviews indicated, that both KMP users and non-users care about attribution when it comes to collaborative student work. This can be seen on the agreement rates of both groups on the statement *"If I made a platform for students to collaborate in, I would add a way to track how much everyone has collaborated. I am not okay with "leeches" getting credit and good grades for not doing anything"*, in which all groups agree, with Student Researchers who do not use KMPs even more strongly agreeing.

Collaboration Details/Methods

- With regard to the statement *"I have to export content from (my app of choice) and send it to my peers. I never share directly from the platform."*,

there are slight differences in opinion by KMP users and non-KMP users (1.5 point median difference, with KMP users agreeing more strongly).

- The statement *"There is not much collaboration in my study. The only occasion where I've collaborated with peers has been for group projects."* gives rise to conflicting opinions, both among KMP users and non-KMP users. Interestingly, however, while in the scope of student researchers the KMP users display a 2 point median advantage over non-KMP users, this difference is reversed in the scope of normal students, where non-KMP users exhibit a 2 point median advantage in agreement over KMP users.

Pains

- There is an important mismatch of agreement in the statement *"There is never enough information about the structure of information in collaboration projects. I spend half of my time looking for files instead of working."* by student researchers. The ones that use KMPs agree moderately strongly with the statement and show a 2.5 more points in the agreement median as opposed to the researchers that do not, which moderately disagree with the statement.

- In the statement *"It's always such a pain to have to share the documents or folders with different people and have to manage the permissions everyone gets. I don't want to have to keep track of that."*, student researchers that use KMPs (that moderately agree with the statement) show 1.5 more points in the agreement median than those student researchers who don't use such platforms (who slightly disagree with the statement).

Favorite Functions

- It seems all the statements distilled from the exploratory interviews generate consensus and agreement among all quadrants. The only exception that can be noticed in the data is that student researchers that don't use KM platforms show a slight disagreement with the statement *"A good collaboration platform would need some sort of moderation. A person who does quality control and can insure the quality of the content."*

- Regarding the statement "In Knowledge Management platforms, Linked References are a function I like and I use actively", while both quadrants inside of the KMP users half agree with the statement, normal students do so more strongly (median = 7) than student researchers (median = 5).

2.5.3 Interaction-Based Framework

Design Specifications and Procedure

Before elaborating a framework, the exact needs and expectations of the users were distilled from the previous steps and made explicit:

- KMP users struggle noticeably with sharing content through their platform of choice. This struggle reportedly comes from the fact that they feel that their peers are not going to be accepting of a new platform. Others worry that they will have to explain the inner-workings of their platform thoroughly to their peers if they share content from it, and they do not want to deal with that added effort.
- From the results of the survey, it seems that a contribution attribution system would bring value to users. However, for some specific segments of the analyzed demographic the opinions are quite polarized, so it would not be good to enforce this tracking.
- By their answers, it can be extracted that users are not weighed down by the prospect of having to change tools / adapt their workflow to another tool. This is a factor that KMPs will inevitably struggle with when trying to nurture an active and loyal community.
- KMP users agree that a collaboration platform for them would need some sort of moderation, preferably in the form of a central moderator figure. This person would ensure the quality of the knowledge contained in the platform.

Knowing these obstacles to efficient student collaboration on KMPs and applying concepts taken from nudge theory and gamification (which have been thoroughly defined and expanded on in the Theoretical Framework of this paper), the following procedures have been devised to design digital interactions to alleviate them:

- To tackle the problem of KMP users not being willing to send content from their platforms to non-users, the effort required by new users to engage with content from the platform must be minimized, both in terms of getting the user acquainted with the platform quickly and in terms of eliminating roadblocks to access the content. However, this challenge is two-fold, as it is also important to provide sufficient encouragement for existing users to decide on sharing their content to peers.

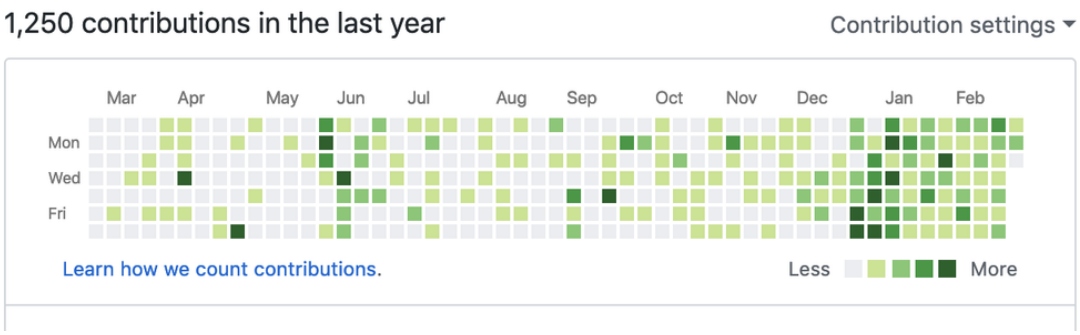


Figure 2.16: Github's visualization of code contributions over time. If developers want to switch to another versioning repository, they will have to deal with the added loss of losing their commit streak.

- An optional contribution tracker must be implemented to account for the requirements of the users. This function could also be used to increase the engagement of the users through gamified interactions. By making users be more encouraged to contribute to collaborative project so they can, for example, score higher on a ranking or show a visual display of their prowess to other users, collaboration becomes richer and the platform also experiences increased user engagement.

- Although not the best option morally, a platform can combat low platform change cost and consolidate its users by introducing gamification mechanisms. By appealing to the users' "sunken cost bias"[1], a platform can gain recurrent users that use the platform simply because they are familiar with it, have invested time and effort into setting up the information infrastructure there, or are compelled to by some other form of extrinsic motivation (a gamified element in the app). An example of a service that employs a practice like this is the language learning application Duolingo [65]. This software uses a system that compels users to access and use it daily to maintain a gamified streak. Even if there are more effective methods for learning a language, users will have incentives to remain in Duolingo, just because the perceived investment they have put in it and the stakes involved in stopping its usage (losing the daily streak). Github [66], the online software version control hosting service, does something similar, among other gamified interactions, with its contribution tracker (see Figure 2.16). If developers want to switch to another versioning repository, they will have to deal with the added loss of losing their commit streak. These two particular examples don't nec-

[1] A bias characterized by individuals continuing a behavior or endeavor as a result of previously invested resources (time, money or effort), even when it does not result in the optimal outcome for them any longer [64]

essarily stimulate collaborative work, but the mechanisms employed in them can be modified for this purpose.

Wireframes

The following figures represent low-fidelity depictions of solutions to the requirements and concerns expressed by the subjects consulted in the Exploratory Interviews and validated through the Quantitative Survey.

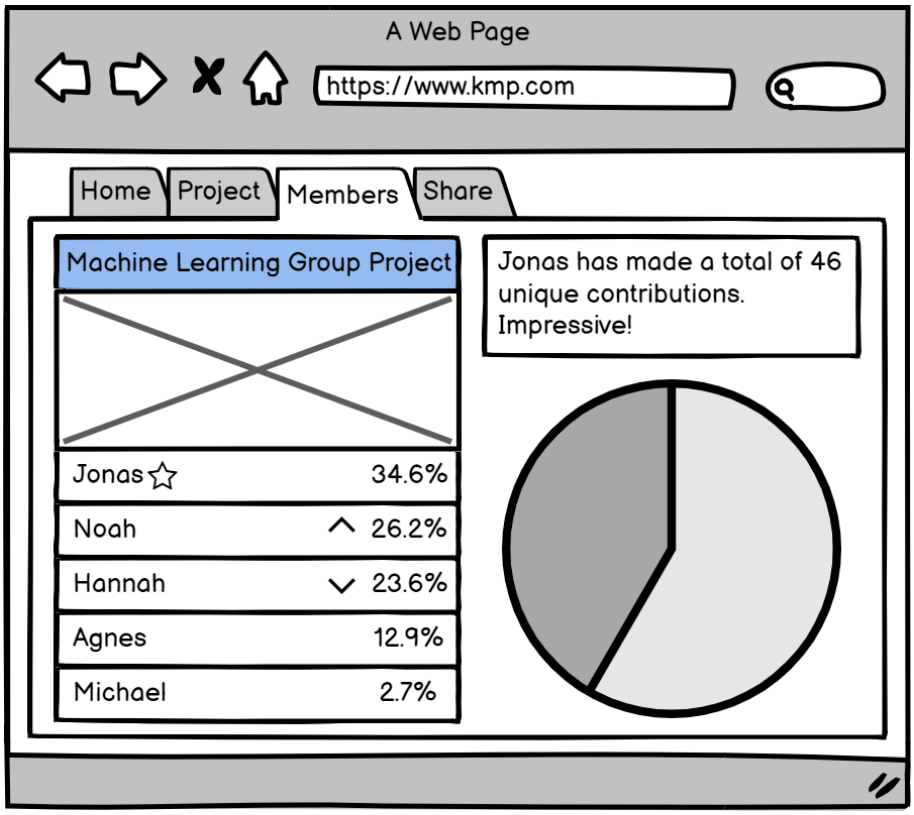


Figure 2.17: A wireframe of a contribution tracking system. The Contribution Leader is made into a desirable position in order to generate competition for it, which translates into increased engagement.

Figure 2.17 represents a wireframe of a contribution tracking system in a KMP. The members of this particular collaborative project are listed on the left side of the screen, ranked by their relative contribution to the project. It can be seen that the leader has a distinction next to their name to indicate merit. Additionally, it can be seen that the members in second and third spots in terms of relative contributions have swapped positions recently, as illustrated by the arrow icons. On the top right side of the content, a customized message provides a metric about the current contribution leader. Below that, a pie chart shows how the totality of the contributions of this collaborative project are divided between all the different contributors.

Looking at the Gamification subsection in the Theoretical Framework (Section 2.3.2), it can be appreciated that this mechanism appeals to the user's desire to influence others. By featuring the highest contributor on top of the ranking and with a distinctive mark, an app can create a micro social hierarchy that puts the highest contributor in a position of leadership and influence. This, in tangible terms, would mean that this user is more prestigious than others inside communities, their contributions are held to a higher esteem and they could have more leverage in creating and structuring new projects. On the other hand, members who are not the top contributor, in a quest for influence and prestige, will be much more engaged and encouraged to participate in the collaborative project.

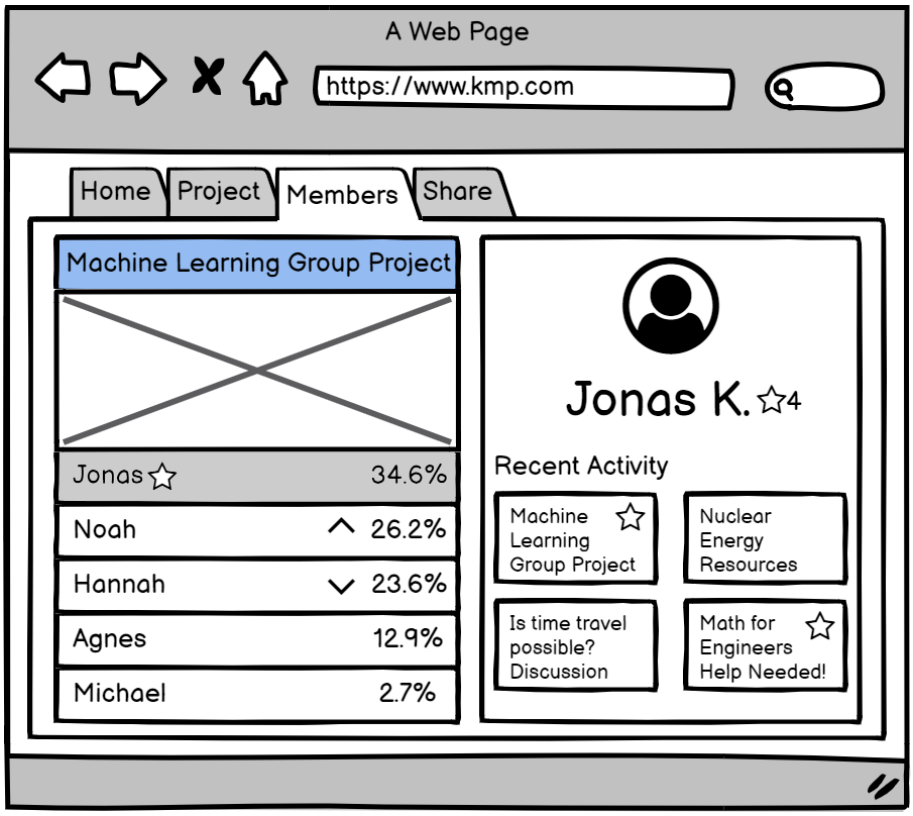


Figure 2.18: A wireframe of a gamified account system. Users can show off their contribution record to other users, which makes them more motivated to dedicate time and effort to this practice.

Figure 2.18 represents a wireframe of a profile view in a KMP. It can be appreciated that, when a person is selected in the list on the left, their global profile can be accessed. In it, it can be seen that the user has 4 stars next to their name, meaning that they are the top contributor in a total of 4 projects. Below that information, the projects where the user has been active recently are shown, with stars if this specific user is the top contributor of those projects as well.

Again, looking at the Gamification literature, it is clear that this interface ele-

ment appeals to the users' desire to be influential. However, this gives another dimension of potential prestige to users, seeing as now they are not just limited to being influential in one specific community project where they are the top contributor, but also they can gain prestige on a platform level, and are able to leverage this clout in every project they belong to.

Furthermore, this screen can also appeal to the users need to belong. We can represent human social bonds by showing the amount of communities a user belongs to. The more communities and the more stars, the greater the feeling of relatedness and belonging can be.

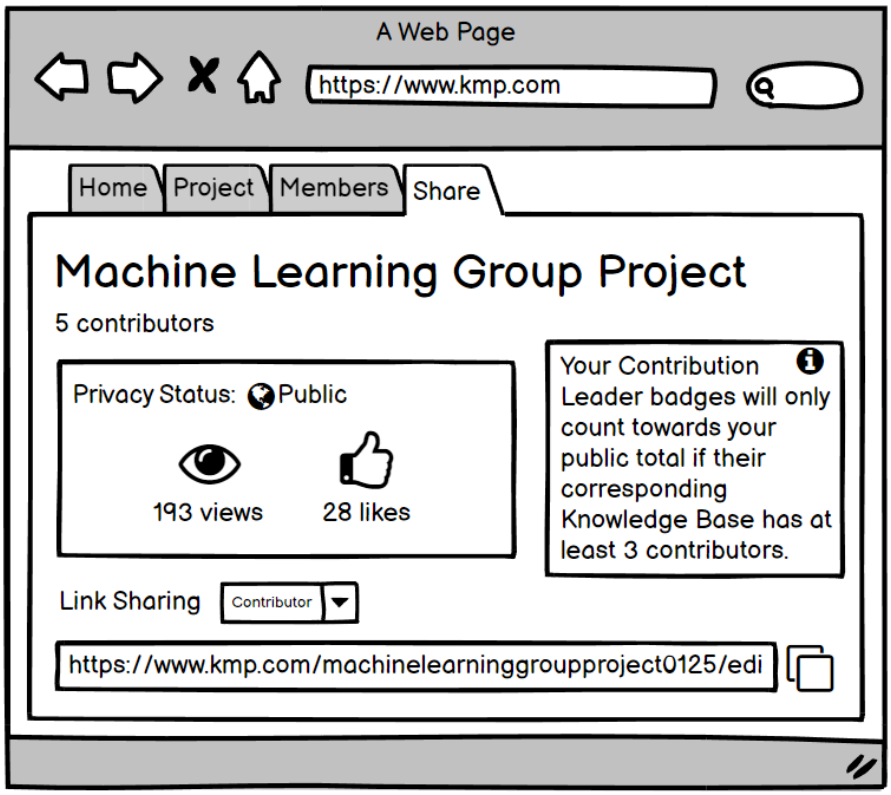


Figure 2.19: A wireframe of a sharing page that encourages the publication and sharing of content. Users will link these social metrics with social success and influence, and will be more engaged in the service in order to maximize them.

Figure 2.19 represents a wireframe of a gamified sharing page in a KMP. There is a section on the left side of the screen that exhibits some statistics related to the popularity of the project in the platform's public space. By default, project's will be public and discoverable by members of the platform. The two metrics that are displayed in this prototype are total views by users outside of the project and total "likes", which can be a way for these users to save these projects for later reference.

Additionally, a big information panel on the right side of the screen notifies the

user that, for a KB in which they are contribution leaders to count towards their publicly displayed total (as seen in previous wireframes), the number of contributors in said KB needs to be at least of 3. This limit can have to advantages. Firstly, it prevents individuals from faking their credentials by creating countless KBs The number of contributors of the project is displayed, to help the user quickly check whether this project qualifies for the aforementioned limit.

Lastly, the bottom of the screen displays a section which allows the members of the project to easily get a shareable link to send to new potential contributors. A simple drop-down menu would allow users to easily modify the purpose of the URL: It could be for inviting new editors, and it could alternatively be for sending a link for someone to just visualize and comment on the project. In any case, the process is extremely simplified.

By setting the artificial minimum of 3 contributors for the status of Contribution Leader of a certain KB, the application nudges users to share their projects and get more contributors in them. This nudge, which could be categorized as a *Reflective-Transparent* nudge and would fall under the *Social Influence* variety discussed in the Theoretical Framework, also plays into the overarching gamification approach to the encouragement of social behavior (users want to share their content more so that it can qualify to give them status inside the platform).

Of course, the metrics page also serves as a gamified tool. Users will link maximizing these metrics with social success and influence, so they will be more encouraged to take actions that increment these numbers, like sharing the project in social media, embedding a link elsewhere...

Figure 2.20 represents a wireframe of the Settings page of a hypothetical KMP. This wireframe was created to illustrate the utility of Nudge Theory on this framework. As it can be appreciated in the image, the settings for the project are hidden behind a menu in the Home page of the project. The Settings menu includes various sections, among which we focus on the Privacy one. This section has, above everything else, a dropdown menu in which users can easily select whether they want this project to be public or private. It is important to note that projects should be automatically set to public upon creation and should remain so until the user indicates the opposite. Below this, there are two other options in the Privacy section, namely ”Link Sharing”, which enables or disables the option for URLs pointing to this project to be shared (as seen on the previous wireframe) and ”Discoverable by Community”, through which the creator of the project can decide whether or not the rest of the KMP’s users can find this project through the Community tab (see next wireframe).

The design decision of putting the project’s settings behind a menu is an intentional one. Default nudges, as named by the existing literature, are pre-set

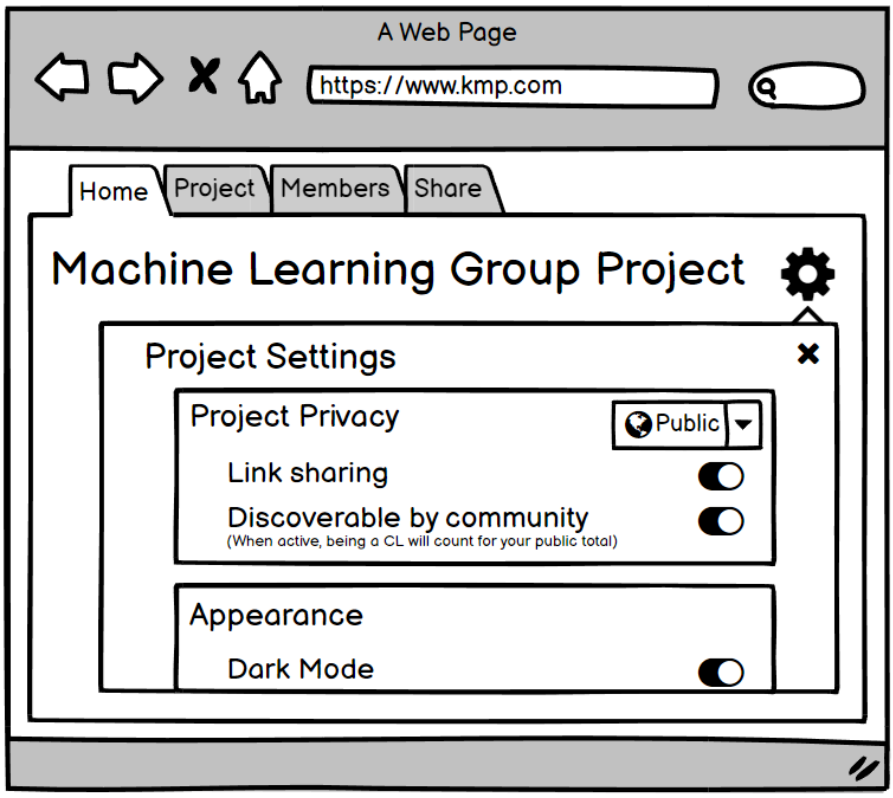


Figure 2.20: A wireframe of a Settings page that nudges users to make their KBs public. If users want a KB in which they are the Contribution Leader to count for their public total, it will have to have at least 3 contributors and also be public for everyone on the platform.

courses of action that take effect if nothing is specified by the decision maker [33]. Setting defaults is an effective nudge when there is inertia or uncertainty in decision making [67]. Since defaults do not require any effort by the decision maker, defaults can be a simple but powerful tool when there is inaction [68]. This concept, applied to a SKM platform, can materialize in a ”public by default” system. A business requirement for KMPs in order to pivot to a more community-oriented business concept is to have users share as much content as possible. This increases the added value for existing users but also for potential new ones. By using this default nudge, effectively all new content is made public, and remains so until the authors indicate otherwise. Users are more likely to keep their work public if the possibility is introduced through this nudge rather than as an option, and with very low level of perceived threat to their freedom of choice, as found by [69].

Furthermore, this wireframe shows continuity when it comes to the gamified technique of only letting certain types of KBs to count for users’ public ”Contribution Leader” counter discussed in previous wireframes. Particularly, this wireframes states that only public KBs that are open to be discovered by members of

the community external to the project will count for this public prestige indicator. This adds another business benefit to the gamified social reward system of this function. Now, if users want a KB in which they are the Contribution Leader to count for their public total, it will have to have at least 3 contributors and also be public for everyone on the platform.

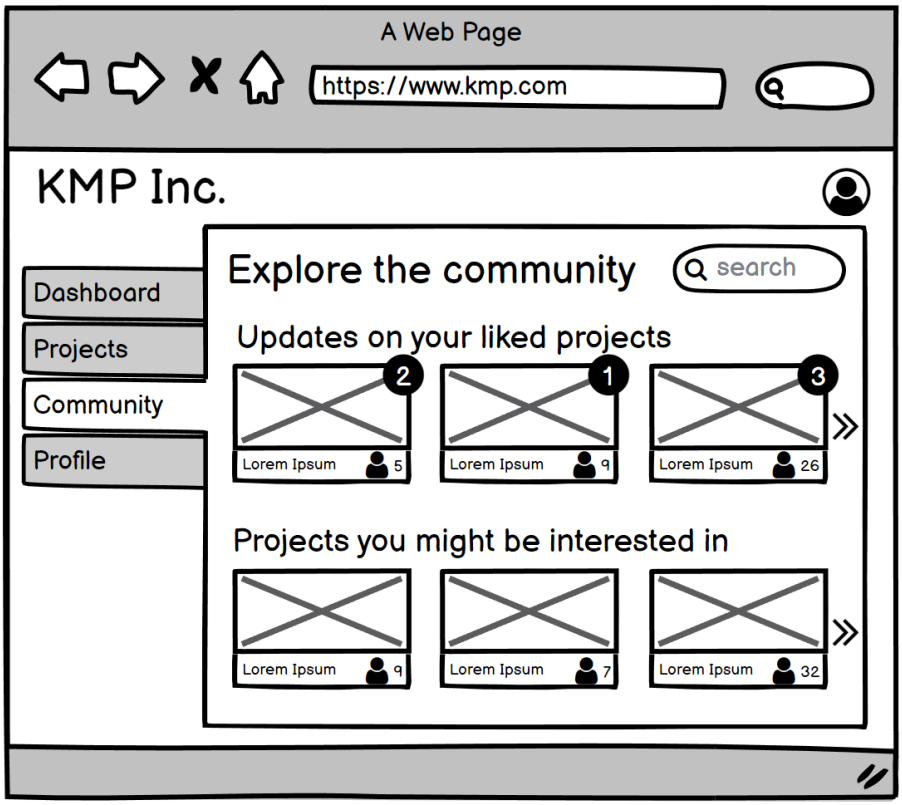


Figure 2.21: A wireframe of a Community tab in which all previously described nudges and gamified mechanisms converge. The behaviors encouraged by the other pages will encourage users to visit this page in search for more projects to discover, participate on and gain even more prestige.

Figure 2.21 depicts a wireframe of the Community tab of a fictional KMP. As it can be appreciated in the image, this tab is on a series of vertical tabs alongside the main Dashboard of the application, the tab with all the user's projects and the tab where the user can visualize their profile. This makes the Community part of the highest level in the tree of functionalities that this digital service offers, which adds to its perceived importance.

It can appreciated that this tab has a search bar. This text input field would allow users to look for users, categories, communities or specific projects inside the KMP. While not pictured in these wireframes, the idea would be to enable the users to ”like” projects that they are interested in, and they would be able to follow their progress from the ”Projects” tab that is above the Community one.

Below the title of the tab and the search bar, there is a section entitled ”Updates on your liked projects”. This section, as the title explains, lets the user preview which of the projects that they have liked have any new updates. In the context of this service, ”liking” a project would mean subscribing to the updates of that specific project. The user can quickly identify the projects by their name and their thumbnail image. On the top left of each project update there is a notification badge that describes how many new updates have been made to that project. On the bottom right, there is an indicator of the number of collaborators that the project has.

Lastly, below this section there is another one entitled ”Projects you might be interested in”. As is the case in many other online software services, this service would look at the user's interests and offer personalized recommendations. This would serve as a portal for users to discover and engage with communities and users with similar interests to them.

Rather than containing gamified mechanics or behavioral nudges, this page would represent a convergence point for all the other nudges seen in previous wireframes. The behaviors encouraged by the other pages will encourage users to visit this page in search for more projects to discover, participate on and gain even more prestige. This page effectively opens the discovery possibilities of users and connects them with a potentially endless supply of new content for them to enjoy and engage with. This will increase the time they spend in the platform, the amount of contributions they make (which generates more value for them, for the KMP and for potential new users) and thus the perceived value of the platform in their workflow.

Case Study: Remnote

The following figures represent high-fidelity implementations of the wireframes discussed in the previous section. While at the moment of writing this paper RemNote does not yet possess officially published collaboration functionalities, these prototypes will pretend that these exist, operating under the assumption that this function will be implemented and released in the future.

The objective in these higher-fidelity prototypes is to show a real-world application of the wireframes shown in the previous section while preserving the gamified/nudging approaches.

Remnote was chosen as a case study because of the unique niche it occupies, which is relevant to the subject matter of this paper, even among PKM platforms. It combines integrated PDF file annotation with note-taking and with Spaced-Repetition-based flashcard creation and usage, making it an all-encompassing

tool for students.

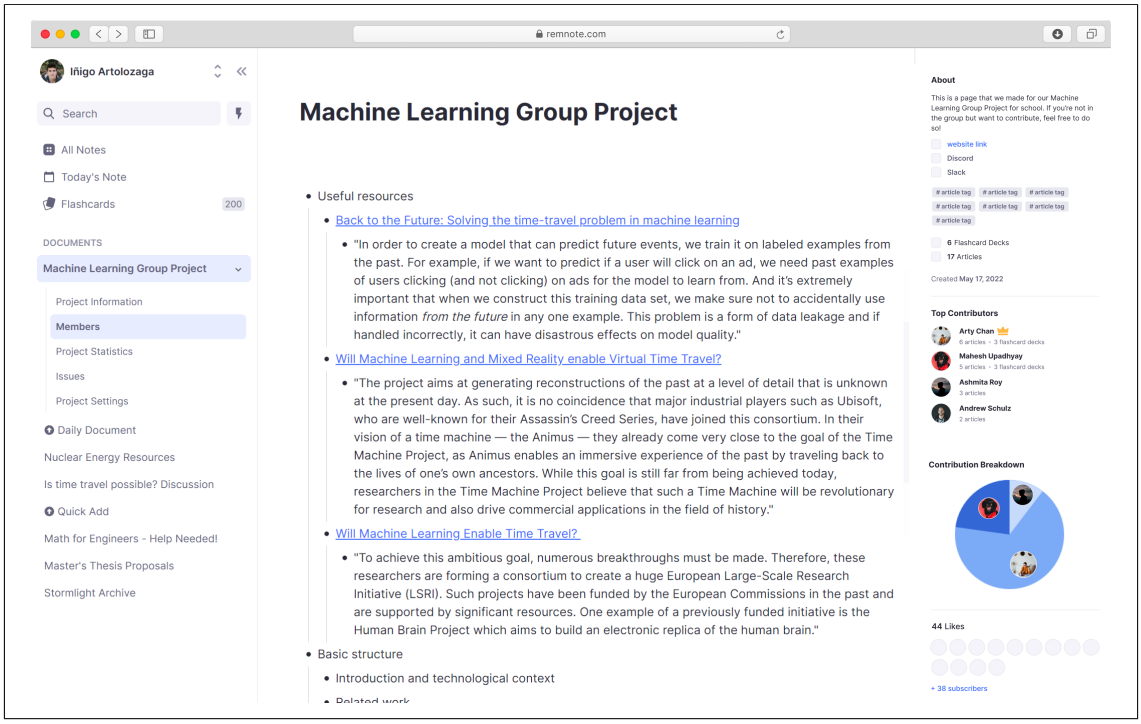


Figure 2.22: A prototype of a possible implementation of a contribution tracking system in RemNote, as proposed in Figure 2.17.

Figure 2.22 represents a high-fidelity prototype of what a possible implementation of a contribution tracking system would look like if implemented in RemNote. It can appreciated that the elements discussed in the lower fidelity counterpart of this concept are present in this prototype:

- For each Project in the left sidebar, a expansion button can be clicked on to access a drop down menu. Among the options that this drop down menu contains, a 'Members' tab can be found, as specified by the low-fidelity wireframe.
- When the 'Members' tab is selected, the content of the project gets pushed to the right to make space for a window with information about the members of the collaborative project.
- The window, aside from the title and chosen image for the project, contains the names of the project's members, with percentages representing the members' relative contribution on the right.
- The contribution leader has their name on top of the list, and has a distinction in the form of a star.

- As in its lower fidelity counterpart, this prototype contains arrows to indicate that the second and third positions with regard to relative contribution have recently been swapped.

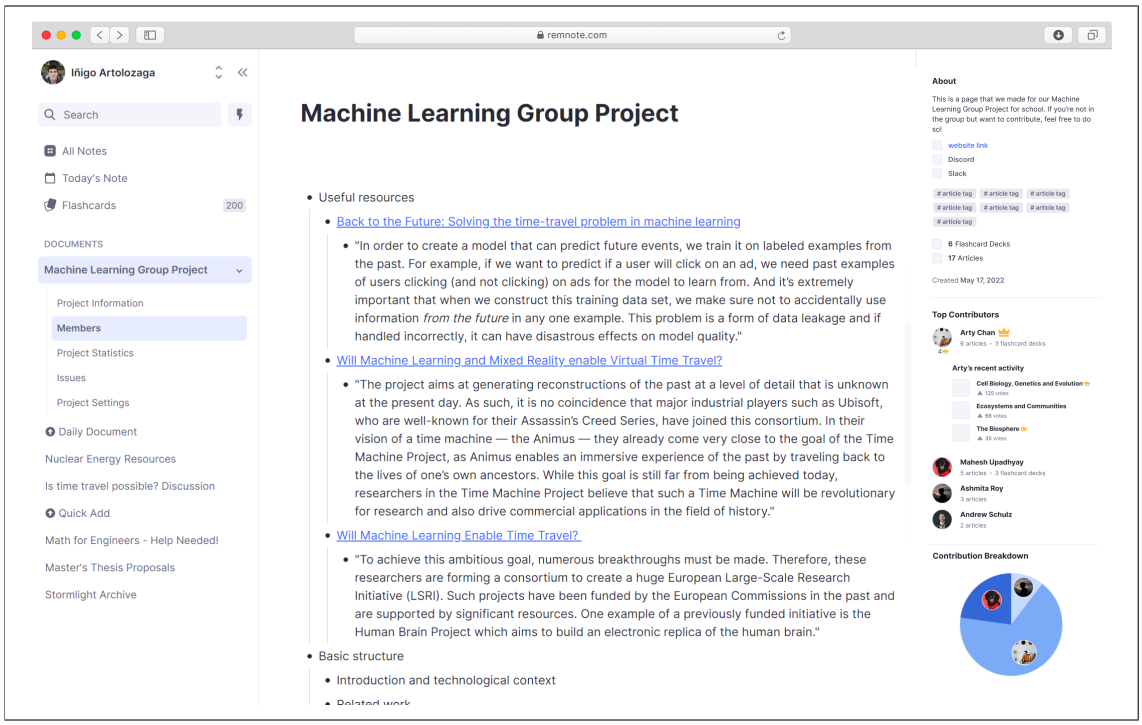


Figure 2.23: A prototype of a possible implementation of a gamified account system in RemNote, as proposed in Figure 2.18.

Figure 2.23 represents a high-fidelity prototype of what a possible implementation of a gamified account system would look like if implemented in RemNote. As it is the case with its lower fidelity counterpart, the following concepts are present in this prototype:

- The state of the pictured prototype can be reached by clicking on the name of any of the project participants on the right sidebar menu. The initial state would look as Figure 2.17. The expanded information would drop down upon click.
- The new screen displays information about the selected individual. In this case, the user's name, profile picture and number of projects where they are the contribution leader can be seen.
- Their recent activity can also be seen, by means of a section which displays the most recent projects where this user contributed.

- The rest of the users and the contribution pie chart can still be seen, for ease of navigation.

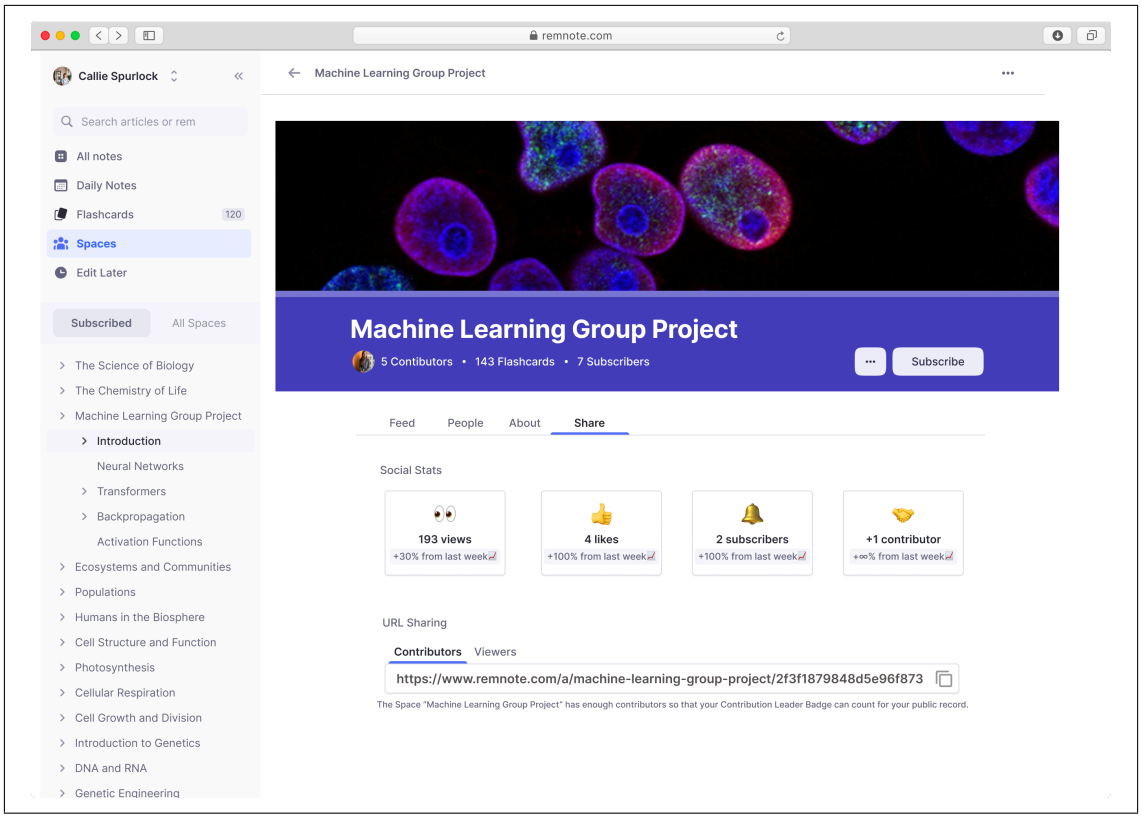


Figure 2.24: A prototype of a possible implementation of a content sharing page that implements Gamification and Nudge Theory techniques, as proposed in Figure 2.19.

Figure 2.24 represents a high-fidelity prototype of what the implementation of a gamified sharing screen for a KB would look like in Remnote. It applies the interface elements proposed in its lower-fidelity counterpart (Figure 2.19) in the following way:

- There is, as specified in the low fidelity prototype, a section with social insights for that specific KB. This higher-fidelity interpretation, aside from views and likes, includes two new metrics for the project, which are new subscriptions (users following the KB's updates) and new collaborators (users who add to the KB).
- The URL sharing section is directly below that. As specified, it includes an easy way to select whether the link will be for inviting new contributors or just to share a viewable version of the project with no editing clearance.
- On this occasion, the message that informs users whether or not the Contribution Leader status in this KB contributes to their public total is in the

URL sharing section. This way, when users are sharing their project to new contributors or thinking about it, they can quickly see whether this project qualifies for their public score or not.

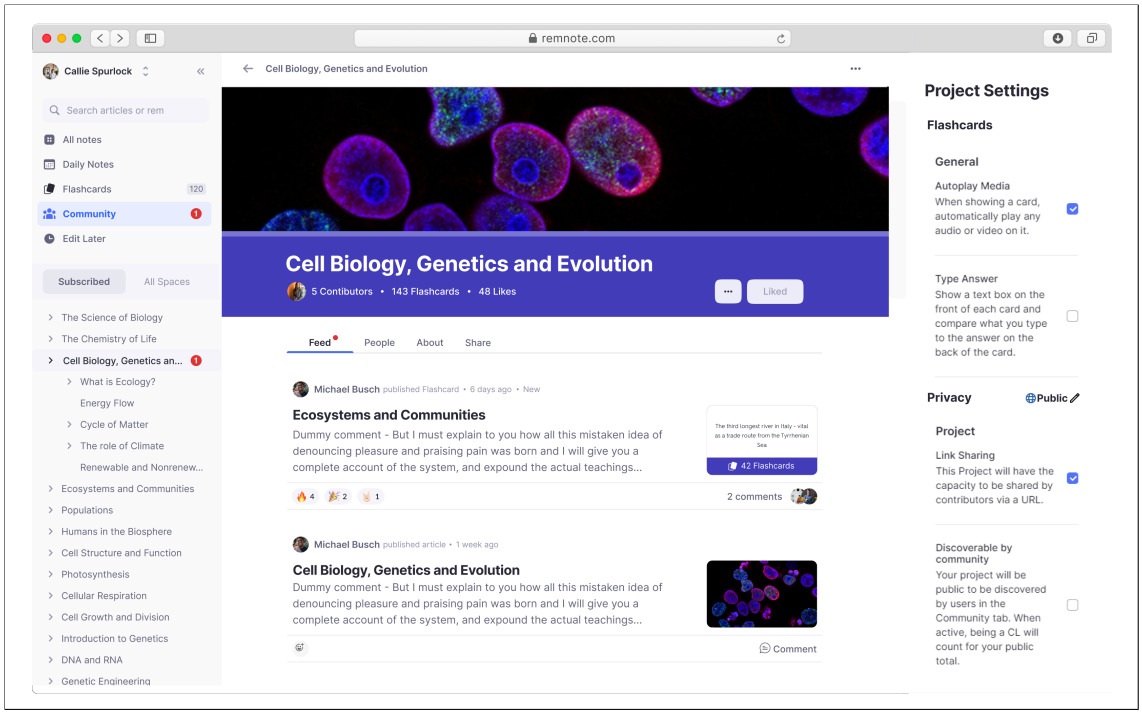


Figure 2.25: A prototype of a possible implementation of a Settings tab that nudges users to publish their projects, as proposed in Figure 2.20.

Figure 2.25 represents a high-fidelity prototype of a potential application of the Settings tab in Remnote. It applies the interface elements proposed in its lower-fidelity counterpart (Figure 2.20) in the following way:

- Using the increased screen size and resolution to our advantage, we can put these menus in the sidebars instead of in the spotlight. In the high-fidelity prototype, the Settings of the project can be accessed without losing sight of the actual project, by using the right sidebar.
- What was previously a drop-down menu designed to choose whether the project would be public or private is now simpler element which allows users to edit the option by clicking on the pencil icon.
- The two togglable options are represented in this prototype in the same manner as they were in the lower fidelity one.

Figure 2.26 represents a high-fidelity prototype of what the implementation of a Community tab for a KB would look like in Remnote. It applies the interface

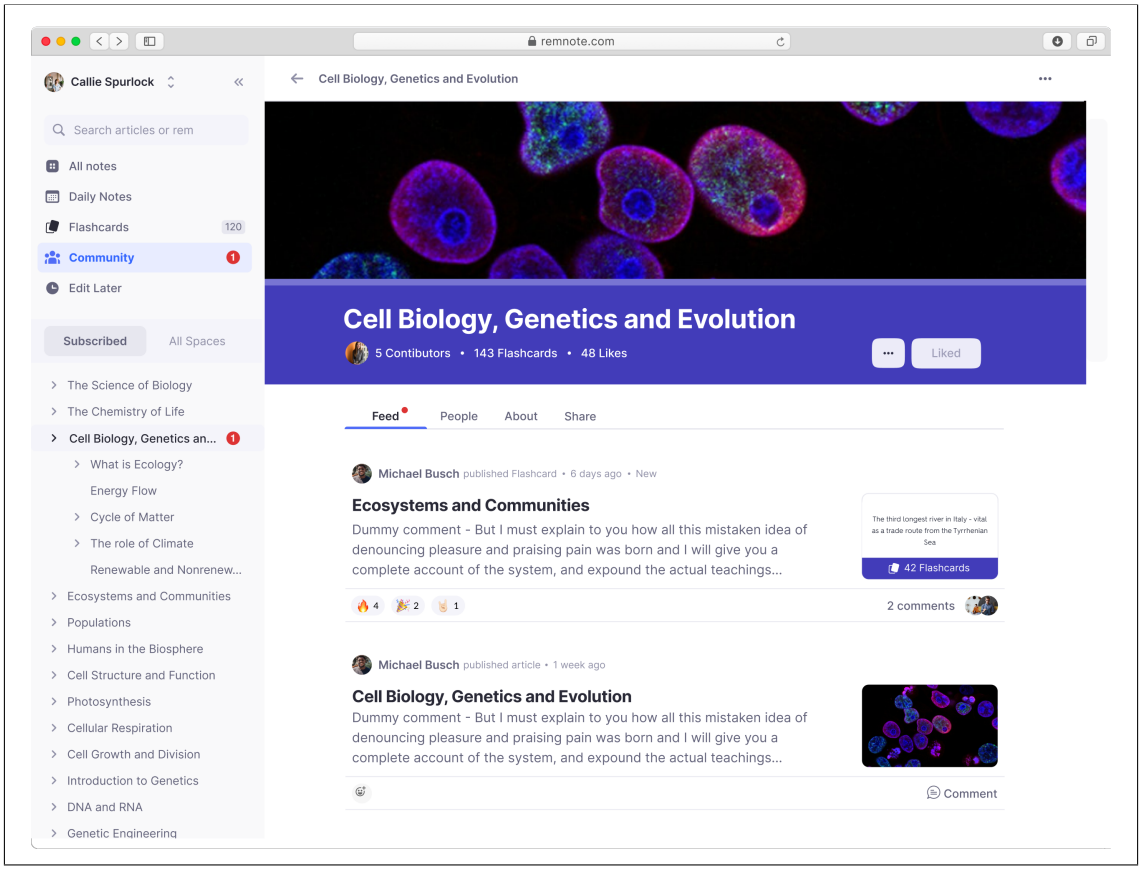


Figure 2.26: A prototype of a possible implementation of a Community page that acts as a convergence point for all other nudges and gamified mechanisms, as proposed in Figure 2.21.

elements proposed in its lower-fidelity counterpart (Figure 2.21) in the following way:

- Due to the increased resolution that the high-fidelity prototypes allow for, more elements can be fit in the screen. Therefore, the menu that took the spotlight in this prototype's low-fidelity counterpart, which included updates on the user's subscribed projects and trending community projects, has been pushed to the left sidebar. As it can be appreciated in the sidebar, there are two tabs, where the user can access the two main sections defined in the low-fidelity prototype. It can also be appreciated that the notifications about updates to the subscribed projects are visible from anywhere in the application, making them eye-catching.

- In the main section, where the elements that are now in the sidebar used to be, there is now space to visualize the actual projects.

Chapter 3

Discussion

3.1 Exploratory Interview and Qualitative Survey

The Exploratory Interviews were effective in capturing an initial set of experiences, expectations and pains regarding Knowledge Management and digital collaboration with peers among the higher education student demographic. Overall, students use digital KM methods to create and collaborate around group work, but only in rare cases do they do it out of their own volition. Additionally, in the majority of cases students hesitate to use collaboration tools that are not popular among their peers or even not officially recommended by their professors.

One factor that was made especially prevalent during the interviews and is worth discussing is that KMP users are much more aware than their non-KMP using counterparts about how much the usage of certain digital tools impacts their performance and overall productivity. During the interviews, these participants highlighted how they perceived their workflow in terms of efficiency with much more insightfulness. This can be caused by two different things:

- KMP users become more critical of tools and how they impact their productivity once they get more experienced trying multiple tools.
- KMP users are naturally more critical of digital tools and for that reason they have naturally begun using more sophisticated KMPs.

Coming back to Jain et al.'s analyzed dimensions of KM for HEIs [5], which can be found in the Related Work section (Section 2.2) several phenomena can be appreciated for each category:

- *Knowledge Creation*: A strong advantage of digital KMP over more traditional methods of storing and managing knowledge is that, by storing information digitally, more complex and nuanced connections can be established between pieces of information. An example of this is the P.A.R.A.

framework, created by Tiago Forte, which allows pieces of knowledge to be linked to a certain Project (time-bound goal with a deadline), and Area of Responsibility (an aspect of an individual's life containing one or more projects) and a Resource (a topic or theme of ongoing interest) [70]. It is obvious that, with the expansion of metadata about pieces of information that digital methods have enabled, the capacity of individuals to encounter novel connections between concepts goes up exponentially. This was made explicit by some of the KMP users that were interviewed: They claimed that using these platforms did not just make them more productive, but also more creative and innovative.

- *Knowledge Transfer*: One of the aims of the proposed SKM philosophy is the free flow of knowledge among communities of individuals with a common objective. One advantage that a platform with such a philosophy would have by design over more design is the implicit knowledge that everyone that is present in the platform is willing to exchange information with any other member of that network for mutual gain. Not only this, but that exchange and compounding of knowledge could also be made public and benefit more people aside from the original collaborators. This last point is not trivial, since as per the interviews it seems that most of students' collaboration that is not done in the context of a group project is done in closed, often small communities. This type of collaboration has few human inputs, and therefore it has few outputs.

- *Knowledge Storage:* Students who reported using less specific digital services to manage their knowledge (like Google Drive) usually also complained that they often struggled with finding information. The severe compartmentalization of information that is characteristic of closed folder-based architectures like that of Google Drive diminishes the users' capabilities of creatively combining information. Everything is stored in a specific directory in a way that makes sense upon first glance, and little to no higher-order combinational thinking can occur with such extreme barriers between concepts that at first glance seemed unrelated but could have had potential as a unit. The same phenomenon occurs with physical note-taking and information storage methods, with notable exceptions (see Zettelkasten [71]). In the case of SKM, Knowledge Storage has deep ties with Knowledge Creation. The aim of a community-based KB would ultimately be a platform which would allow individuals to generate new ideas by combining their tacit knowledge with other's public external knowledge and make them public to become the piece someone uses to start the same process themselves.

- Knowledge Culture: This section is arguably the one where the most work is needed to achieve a massive demand for KMPs in HEIs. A lot of factors are at play that make the Knowledge Culture among university students noticeably weak. Most importantly, from the interviews there does not seem to be a pervasive sense of community among students partaking in the same courses. As mentioned before, most of the Knowledge Transfer happens among small, tight-knit groups of friends that share academic objectives, and less so among larger student communities.

- ICTs: As mentioned in previous sections, big technological corporations have made it extremely convenient for students to centralize their workflow on a single suite of programs. For example, there were multiple interviewed students who almost exclusively used Google-owned services in their digital academic workflows: ”Get the class slides in Google Slides, take notes in Google Docs, meet my project group in Google Meet and collaborate in our shared Google Drive Folder...”. While it is undoubtedly convenient to work like this, it is interesting to analyze whether feeling the need to use exclusively tools from one company can result in a loss of productivity from a mismatch in needs and that company’s offered solutions.

Overall, the results of the survey provide evidence of the validity of the assertions presented in the Exploratory Interviews. Although there were some answers that clashed with the initial expectations (listed below), the overarching conclusion is that the responses that were given by the participants of the Exploratory Interviews are representative of the opinions of the student demographic as a whole.

The aforementioned idea that KMP users are much more aware than their non-KMP using counterparts about how much the usage of certain digital tools impacts their performance and overall productivity is visible in the agreement rates to the statement *”There are a lot of steps in collaboration that take too much time. Some people still use email for communicating and it’s so frustrating”*.

3.2 Interaction Framework

The objective of the Interaction Framework was to provide a clear, literature-backed route for KMPs to implement a more SKM-based platform through the use of purposeful interaction design. This was achieved through use of techniques taken from the field of Persuasive Technology, which enabled certain interface elements to satisfy the users’ needs and expectations while also nudging them to perform actions and carry out behaviors which further the business goals of the PKM.

All in all, Persuasive Technology appears to be the most validated discipline in literature to alter users' behavior inside of a digital medium without sacrificing the UX of the individuals that use it.

The importance of a set of techniques that aim to intercede with users' motivations and intentions being well studied and developed cannot be understated. There are important ethical implications to these practices that should be taken into consideration, and the extensive literature that exists regarding the ethics of gamification and Nudge Theory enables the choice of the least intrusive, most respectful configurations when it comes to engaging with the user.

The proposed framework combines techniques from both gamification and Nudge Theory in a way that makes several core characteristics of the KMP generate momentum towards users sharing their content and engaging with others' content. It does this by generating synergies between different sections of the service and a new "Community" section, in which all the proposed persuasive techniques converge.

While the prototypes presented and analyzed in this paper are built upon tested methods and mechanisms, it remains to be seen whether these techniques would cause a positive effect in users' acceptance of the application and their engagement in it.

Chapter 4

Conclusions and recommendations

4.1 Conclusions

Coming back to the initial Research Questions:

- **RQ1: What are the main uses and expectations of higher education students with respect to KMPs?**: The results of the Exploratory Interviews and the Validation Survey can tell us that the main uses for shared KMPs among HEI students are:
  - As a centralized Knowledge Base. Both for personal and academic use, students are attracted to having a unified repository of all the knowledge they consider worth safekeeping.
  - As a platform to share resources relevant to a topic of common interest between members. In most of the reported cases, these resources were of academic interest, but there were also some cases of collaborative projects of the personal kind.
  - In the case of students that are carrying out academic research, as a connected Reference Manager. The expanded connectivity that these platforms offer appeals to student researchers that want to establish potentially innovative connections between concepts.

  Furthermore, the main expectations of students (both those who use such platforms and those who do not) related to the concept of a social KMPs are:
  - Simultaneous Edition: As mentioned before, editing locally and then sending files to another person for them to edit is perceived as obsolete and inefficient by most interviewees.

  - Linked References: The ability to generate links between concepts and be able to access them quickly allows students to connect ideas and learn more effectively.
  - Easy export/sharing: Users tend to share more and are more willing to get more users in a platform which makes it easy to share content.

- **RQ2: What enables and deters students from engaging with the collaborative aspects of the main KMPs?**: The results of the Exploratory Interviews and the Validation Survey can tell us that the main pains with students' current collaborative experiences are:

  - Not having enough information about structure of the information. When collaborative efforts happen with little to no planning and without the right digital tools, there are always conflicts with how information is structured, and this leads to productivity plummeting.
  - Not being comfortable with sharing content directly with non-KMP users. Users of these platforms do not want to have to go through all the hurdles of onboarding new users, especially if this process is long and cumbersome. Therefore, they prefer to export and share content from the KMPs through copying and pasting or taking screenshots.
  - Privacy-related information not being easily accessible or editable. Users are likely to be put off by privacy settings being hard to manage, or even to find.

- **RQ3: How can an application be designed to encourage students to participate in a shared KB?**: The research that went into Knowledge Management (both Personal and Group-oriented) and Persuasive Technology tell us that the following techniques are useful to encourage social behaviors inside of a KMP:

  - Gamification is an effective method to engage users on digital systems. For the case of HEI students on KMPs, gamification techniques could be used to appeal to individuals' desire to influence others (encouraging more contributions to KBs by publicly rewarding overachievers) and individuals' desire to belong and be influenced (connecting users through the communities they share).
  - Nudge Theory also can be extremely effective for shaping the nature of the interactions inside of a KMP. By ethically leveraging nudging techniques that would aim to facilitate the student's usage of the service, increase the student's perceived social influence or positively reinforce

behaviors that align with the platform's community-building efforts, any KMP could benefit from Nudge Theory to cultivate a strong community.

All in all, the main takeaway is that the HEI student demographic is much more complex and heterogeneous than it appears upon first inspection. There are countless variables that influence students' approach to information and collaboration around it.

According to the results, the characteristic that provides the most information about students' KM habits is whether they conduct academic research as part of their studies or if they do not. The workflow of students that perform academic research is comprised of various information-dense steps, which in turn makes individuals belonging to this group feel a greater necessity to use more explicit KM methodologies, which more tangibly entails a higher propensity to using KMPs.

The nature of individuals' studies is a dimension that does not have as big of an impact as initially hypothesized. A plausible explanation for this is that the democratization of the Internet, coupled with globalization, has caused a homogenization of digital routines across the world and a convergence on specific tools.

By combining techniques inspired by disciplines like Nudge and Gamification Theory, a system can be devised through which KMPs can encourage its users to start organically creating a community. There is a noticeable overlap in these two disciplines, which studies the impact that the need for social conformance can have on the decision-making processes of individuals. People's desire for social validation and influence is an understated dimension of their subconscious decision-making mechanism, and it can be used to the advantage of a digital platform to inspire its users to build a community in it.

4.2 Limitations

The sample of students interviewed as part of the Exploratory Interview phase was relatively small (10 students) and it was extremely geographically, culturally and academically heterogeneous. While the quantitative survey alleviated this potential statistical non-representativeness, an initial study with a larger, more focused sample could have added more legitimacy to the results.

The sample of students who are not conducting research as part of their academic life was significantly small in the validation survey (23 subjects). For this reason, the conclusions reached in this step regarding this group are not as statistically strong as they could have been with a larger sample.

Perhaps due to the fact that there was a potential reward (a gift card) offered as a raffle for a lucky participant, the Qualitative Survey was swarmed by respon-

dents that took the survey more than once with the objective of improving their chances of being chosen as the winner of the reward. Luckily, information about the response times could be cross-analyzed to detect suspicious response patterns. Also, response similarity was taken into consideration to decide whether a response was legitimate or not. The submissions that were discarded were not taken into consideration for the analysis that was presented in this paper.

The Interaction Framework uses raw amount of contributions as a key performance indicator for how successfully the community aspect of the KMP is thriving. However, it could be argued that the quality of these contributions should also play a part in measuring the success of the implementation. For future iterations of the framework, quality should be considered, and not just quantity.

4.3 Future Work

As mentioned in the Limitations section above, a larger, more localized sample for the Exploratory Interviews could have added more legitimacy to this section's results. In the future, an adaptation of this study with a more local perspective, while perhaps not as informative for global KMP, could provide a more representative picture of the situation for a more specific population segment.

It remains to be ascertained whether this framework can cause a positive impact on stimulating the creation of a community in a real KMP. In the future, the optimal route for this area of research would be to implement this framework on a real case and measure its effectiveness when compared to a control group.

Bibliography

[1] S. Maravilhas and J. Martins, "Strategic knowledge management in a digital environment: Tacit and explicit knowledge in fab labs," *Journal of Business Research*, vol. 94, pp. 353–359, 2019. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0148296318300675

[2] E. Ferrero-de Lucas, I. Cantón-Mayo, M. Menéndez-Fernández, and A. Escapa-González, "Ict and knowledge management in teaching and engineering students," *Comunicar*, vol. 29, no. 66, pp. 57–67, 2021.

[3] Swiftype, "What is knowledge management software?" 2020. [Online]. Available: https://swiftype.com/search/what-is-knowledge-management-software

[4] J. J. Kidwell, K. M. Vander Linde, and S. L. Johnson, "Knowledge management practices," 2001.

[5] N. Jain and V. Gupta, "The impact of knowledge management system on student performance," *VINE Journal of Information and Knowledge Management Systems*, vol. 49, no. 1, p. 115–135, 2019.

[6] S.-H. Chiu, "Students' knowledge sources and knowledge sharing in the design studio—an exploratory study," *International Journal of Technology and Design Education*, vol. 20, no. 1, pp. 27–42, 2010.

[7] I. Arshad, "The impact of knowledge management practices in improving student learning outcomes in educational institutions," Jun 2014. [Online]. Available: https://www.academia.edu/6738475/The_Impact_of_Knowledge_Management_Practices_in_Improving_Student_Learning_Outcomes_in_Educational_Institutions

[8] F. Muqadas, M. Rehman, U. Aslam *et al.*, "Exploring the challenges, trends and issues for knowledge sharing: A study on employees in public sector universities," *VINE Journal of Information and Knowledge Management Systems*, 2017.

[9] Y. A. Jalili, “I rather share my knowledge: Applying gamification approach and nudge theory to develop an incentive system,” *VINE Journal of Information and Knowledge Management Systems*, 2019.

[10] M. Al-Emran, V. Mezhuyev, and A. Kamaludin, “Students’ perceptions towards the integration of knowledge management processes in m-learning systems: a preliminary study,” *International Journal of Engineering Education*, vol. 34, no. 2, pp. 371–380, 2018.

[11] S. Garner, “Supporting the personal knowledge management of students with technology,” in *Proceedings of Informing Science & IT Education Conference (InSITE)*. Citeseer, 2010, pp. 237–246.

[12] C. E. Connelly, D. Zweig, J. Webster, and J. P. Trougakos, “Knowledge hiding in organizations,” *Journal of organizational behavior*, vol. 33, no. 1, pp. 64–88, 2012.

[13] C. N.-L. Tan, “Knowledge management acceptance: Success factors amongst small and medium-size enterprises,” *American Journal of Economics and Business Administration (AJEBA)*, vol. 3, pp. 73–80, 01 2011.

[14] A. Pascal, C. Thomas, and A. G. L. Romme, “Developing a human-centred and science-based approach to design: the knowledge management platform project,” *British Journal of Management*, vol. 24, no. 2, pp. 264–280, 2013.

[15] G. D. Bhatt, “Organizing knowledge in the knowledge development cycle,” *Journal of knowledge management*, 2000.

[16] G. M. Marakas, *Decision support systems in the 21st century*. Prentice Hall Upper Saddle River, 2003, vol. 134.

[17] K. M. Wiig, “Knowledge management: an introduction and perspective,” *Journal of knowledge Management*, 1997.

[18] C. Despres and D. Chauvel, “Knowledge management (s),” *Journal of knowledge Management*, 1999.

[19] D. Pauleen, “Personal knowledge management: putting the “person” back into the knowledge equation,” *Online information review*, 2009.

[20] G. Cheetham and G. Chivers, “Towards a holistic model of professional competence,” *Journal of European industrial training*, 1996.

[21] ——, "The reflective (and competent) practitioner: a model of professional competence which seeks to harmonise the reflective practitioner and competence-based approaches," *Journal of European industrial training*, 1998.

[22] J. L. Frand and C. G. Hixson, "Personal knowledge management: Who? what? why? when? where? how?" 1998.

[23] B. E. Clemente and V. J. Pollara, "Mapping the course, marking the trail [personal knowledge management]," *IT professional*, vol. 7, no. 6, pp. 10–15, 2005.

[24] R. Maier and T. Hadrich, "Knowledge management systems," in *Encyclopedia of Knowledge Management, Second Edition*. IGI Global, 2011, pp. 779–790.

[25] K. Huotari and J. Hamari, "Defining gamification: a service marketing perspective," in *Proceeding of the 16th international academic MindTrek conference*, 2012, pp. 17–22.

[26] J. Hamari, "Transforming homo economicus into homo ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service," *Electronic commerce research and applications*, vol. 12, no. 4, pp. 236–245, 2013.

[27] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: defining" gamification"," in *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, 2011, pp. 9–15.

[28] J. Hamari, J. Koivisto, and H. Sarsa, "Does gamification work? – a literature review of empirical studies on gamification," in *2014 47th Hawaii International Conference on System Sciences*, 2014, pp. 3025–3034.

[29] P. Zhang, "Motivational affordances: Fundamental reasons for ict design and use," *Communications of the ACM*, vol. 51, pp. 145–147, 10 2008.

[30] E. Brangier and J. Bastien, *Ergonomie des produits informatiques : faciliter l'expérience utilisateur en s'appuyant sur les notions d'accessibilité, utilisabilité, émotionnalité et d'influençabilité."?*, 08 2010, pp. 307–328.

[31] C. Marache-Francisco and E. Brangier, *The Gamification experience: UXD with gamification background*, 01 2013.

[32] C. Simon, M. Tagliabue *et al.*, “Feeding the behavioral revolution: Contributions of behavior analysis to nudging and vice versa,” *Journal of Behavioral Economics for Policy*, vol. 2, no. 1, pp. 91–97, 2018.

[33] R. H. R., Thaler and C. Sunstein, *Nudge: Improving decisions about health, wealth, and happiness*. Penguin Books, 2009.

[34] A. Caraban, L. Konstantinou, and E. Karapanos, “The nudge deck: A design support tool for technology-mediated nudging,” in *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 2020, pp. 395–406.

[35] C. Hang, T. Ono, and S. Yamada, “Designing nudge agents that promote human altruism,” 10 2021.

[36] M. Möllenkamp, M. Zeppernick, and J. Schreyögg, “The effectiveness of nudges in improving the self-management of patients with chronic diseases: A systematic literature review,” *Health Policy*, vol. 123, no. 12, pp. 1199–1209, 2019. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0168851019302283

[37] S. Giraud and M. Chammat, “L’éthique du nudge: pour un usage responsable d’une approche comportementale au service des politiques publiques,” *Intellectica*, vol. 70, no. 1, pp. 83–96, 2019.

[38] A. Caraban, E. Karapanos, D. Gonçalves, and P. Campos, “23 ways to nudge: A review of technology-mediated nudging in human-computer interaction,” in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 2019, pp. 1–15.

[39] C. R. Sunstein, “Impersonal default rules vs. active choices vs. personalized default rules: A triptych,” *Active Choices vs. Personalized Default Rules: A Triptych (May 19, 2013)*, 2013.

[40] J. Egebark and M. Ekström, “Can indifference make the world greener?” *Journal of Environmental Economics and Management*, vol. 76, pp. 1–13, 2016.

[41] W. Samuelson and R. Zeckhauser, “Status quo bias in decision making,” *Journal of risk and uncertainty*, vol. 1, no. 1, pp. 7–59, 1988.

[42] M. Harbach, M. Hettig, S. Weber, and M. Smith, “Using personal examples to improve risk communication for security & privacy decisions,” in *Proceedings of the SIGCHI conference on human factors in computing systems*, 2014, pp. 2647–2656.

[43] B. Fasolo, R. Misuraca, G. Mcclelland, and M. Cardaci, “The attraction effect in an online shopping environment,” 2006.

[44] T. Gilovich, V. H. Medvec, and K. Savitsky, “The spotlight effect in social judgment: an egocentric bias in estimates of the salience of one’s own actions and appearance.” *Journal of personality and social psychology*, vol. 78, no. 2, p. 211, 2000.

[45] P. G. Hansen and A. M. Jespersen, “Nudge and the manipulation of choice: A framework for the responsible use of the nudge approach to behaviour change in public policy,” *European Journal of Risk Regulation*, vol. 4, no. 1, pp. 3–28, 2013.

[46] N. Föbker, “Can you resist?: The influence of limited-time scarcity and limited-supply scarcity on females and males in hotel booking apps,” Master’s thesis, University of Twente, 2018.

[47] S.-S. Lee, Y.-k. Lim, and K.-p. Lee, “A long-term study of user experience towards interaction designs that support behavior change,” in *CHI’11 Extended Abstracts on Human Factors in Computing Systems*, 2011, pp. 2065–2070.

[48] Google, “Google forms.” [Online]. Available: https://www.google.com/forms/about/

[49] ——, “Google meet.” [Online]. Available: https://meet.google.com/

[50] Zoom, “Video conferencing, cloud phone, webinars, chat, virtual events: Zoom.” [Online]. Available: https://zoom.us/

[51] A. Blandford, D. Furniss, and S. Makri, “Qualitative hci research: Going behind the scenes,” *Synthesis lectures on human-centered informatics*, vol. 9, no. 1, pp. 1–115, 2016.

[52] J. Chin, “Highlight tool.” [Online]. Available: https://workspace.google.com/marketplace/app/highlight_tool/65634221687

[53] Figma, “Design, prototype, and gather feedback all in one place with figma.” [Online]. Available: https://www.figma.com/design/

[54] S. Portigal, *Interviewing users: how to uncover compelling insights*. Rosenfeld Media, 2013.

[55] Google, “Google forms.” [Online]. Available: https://www.google.com/forms/about/

[56] Microsoft, “Microsoft excel spreadsheet software: Microsoft 365.” [Online]. Available: https://www.microsoft.com/en-us/microsoft-365/excel

[57] A. Joshi, S. Kale, S. Chandel, and D. Pal, “Likert scale: Explored and explained,” *British Journal of Applied Science & Technology*, vol. 7, pp. 396–403, 01 2015.

[58] K. Finstad, “Response interpolation and scale sensitivity: Evidence against 5-point scales,” *Journal of usability studies*, vol. 5, no. 3, pp. 104–110, 2010.

[59] “Analysing likert scale/type data,” 2009. [Online]. Available: https://www.st-andrews.ac.uk/media/ceed/students/mathssupport/Likert.pdf

[60] P. Guilizzoni, “Balsamiq wireframes - industry standard low-fidelity wireframing software: Balsamiq,” 2022. [Online]. Available: https://balsamiq.com/wireframes/

[61] Remnote, “The all-in-one tool for thinking and learning.” [Online]. Available: http://www.remnote.com/

[62] “Zotero - your personal research assistant.” [Online]. Available: https://www.zotero.org/

[63] Elsevier, “Mendeley reference manager,” 2022. [Online]. Available: https://www.mendeley.com/reference-management/reference-manager

[64] H. R. Arkes and C. Blumer, “The psychology of sunk cost,” *Organizational behavior and human decision processes*, vol. 35, no. 1, pp. 124–140, 1985.

[65] Duolingo, “Learn a language for free,” 2022. [Online]. Available: https://www.duolingo.com/info

[66] “Github features: The right tools for the job.” [Online]. Available: https://github.com/features

[67] A. Samson, “The behavioral economics guide 2014,” *London, UK: Behavioral Economics Group*, 2014.

[68] A. Samson and P. Ramani, “Finding the right nudge for your clients,” Apr 2021. [Online]. Available: https://www.investmentnews.com/finding-the-right-nudge-for-your-clients-75761

[69] P. Michaelsen, L.-O. Johansson, and M. Hedesström, “Experiencing default nudges: autonomy, manipulation, and choice-satisfaction as judged by people themselves,” *Behavioural Public Policy*, p. 1–22, 2021.

[70] T. Forte, “The para method: A universal system for organizing digital information,” Jun 2022. [Online]. Available: https://fortelabs.co/blog/para/

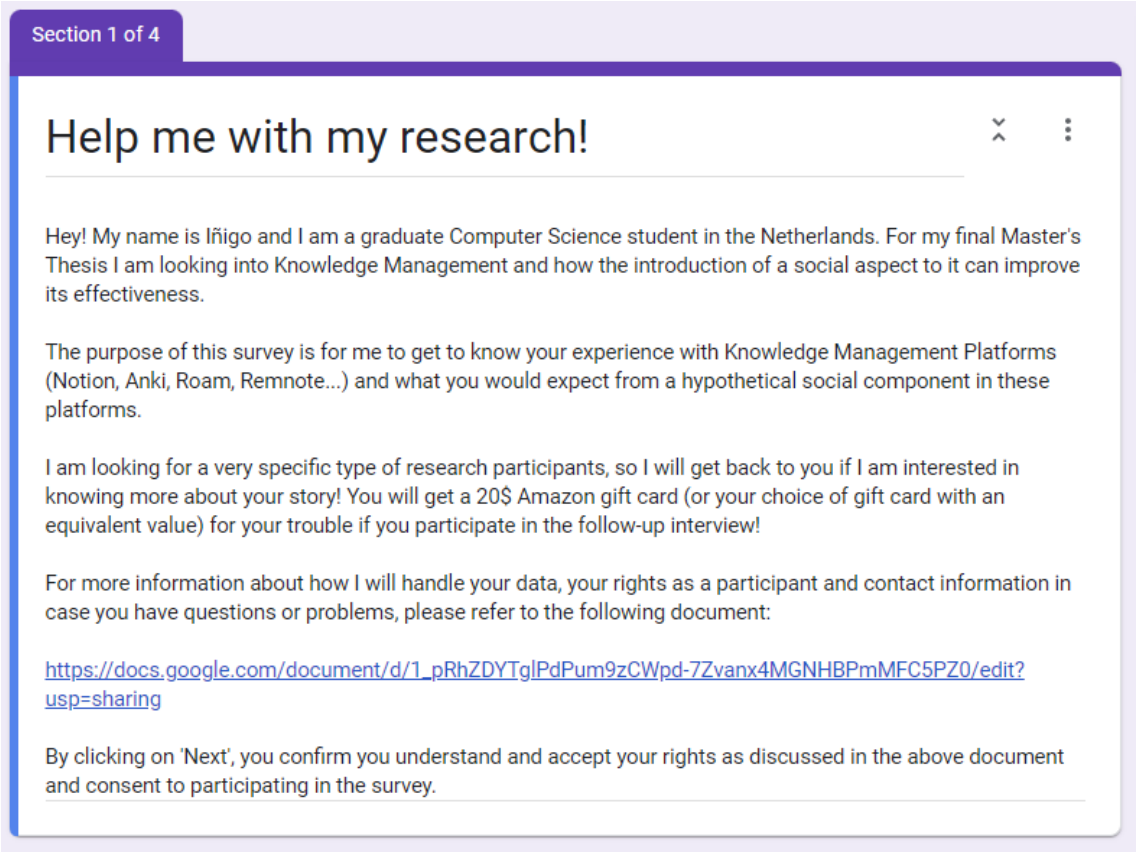
[71] C. Tietze, “Zettelkasten.” [Online]. Available: https://zettelkasten.de/posts/overview/

Appendix A

Appendix

A.1 Preliminary Interviews

A.1.1 Screener Survey for the Preliminary Interview


Section 1 of 4

Help me with my research!

Hey! My name is Iñigo and I am a graduate Computer Science student in the Netherlands. For my final Master's Thesis I am looking into Knowledge Management and how the introduction of a social aspect to it can improve its effectiveness.

The purpose of this survey is for me to get to know your experience with Knowledge Management Platforms (Notion, Anki, Roam, Remnote...) and what you would expect from a hypothetical social component in these platforms.

I am looking for a very specific type of research participants, so I will get back to you if I am interested in knowing more about your story! You will get a 20$ Amazon gift card (or your choice of gift card with an equivalent value) for your trouble if you participate in the follow-up interview!

For more information about how I will handle your data, your rights as a participant and contact information in case you have questions or problems, please refer to the following document:

https://docs.google.com/document/d/1_pRhZDYTglPdPum9zCWpd-7Zvanx4MGNHBPmMFC5PZ0/edit?usp=sharing

By clicking on 'Next', you confirm you understand and accept your rights as discussed in the above document and consent to participating in the survey.

Section 2 of 4

Personal Information

Please bear in mind that any information you provide that could be traced back to you will be stored and analysed privately and will be deleted immediately upon the completion of our research. For more information, please refer to the document mentioned in the introduction of this survey.

Please indicate your sex (Optional)

- Female
- Male
- None of the above

How old are you? (Optional)

- 18-21
- 22-25
- 25+

Please tell me your email (you'll be contacted if you match my desired demographic!)

Short answer text

Section 3 of 4

Your experience with Knowledge Management Platforms

Description (optional)

For how long have you been using Knowledge Management Platforms (Notion, Roam Research, Anki, Remnote...)? *

- I'm fairly new to the concept (<6 months)
- I'm quite experienced with them (6 months - 2 years)
- I'm a veteran! (>2 years)

Do you use / have you used KMPs in an academic context? *

- Yes
- No

Section 4 of 4

Tell us more about it!

Description (optional)

Do/did you use the platform alone or with friends/peers? *

- Alone
- With friends/peers

Please briefly describe your routine/experience with the platform:

Long answer text

Do/did you share content with your friends/peers through the platform?

- I shared directly from the platform
- I exported content and then shared it
- I didn't share content

Can you tell us about any problems you encountered using the platform in terms of compatibility or shareability?

Long answer text

A.1.2 Preliminary Interview Script

Encouraging Knowledge Sharing among Student Groups through Knowledge Management Platforms

Initial Interview

Objective of the interview:
Gain a better understanding of how students perceive collaboration among peers in an academic setting, even when this collaboration is not done in the frame of a group project. Understand the role that technology plays in collaborative environments in universities and how it can be used to catalyze social interaction within a student community.

Interview Method:
- Sample size: Approx. 10 people (preferably 50/50 sex split, variation in majors/occupations).
- Estimated duration: 30min/interview.
- Interviews will be conducted by video/voice conference.
- Interview audio will be recorded, stripped of any identifiable information.

Definition of KMP to give interviewees:
"A digital service that helps a group of users with a common objective gather, represent, store and redistribute knowledge for a range of purposes." Examples of such services include Notion, Anki, Roam Research, Remnote...

Question Categories (and role):
- **Open discovery questions:** Get the conversation going, get the participant in the mindset to recall information about the subject matter, obtain a wide perspective of the participant's view on the subject.
- **Understanding user tasks/activities:** Gain more information about how exactly the participant performs tasks or activities related to the subject matter.
- **Performing/showing:** Getting a walkthrough of the most relevant tasks related to the subject matter by the participant.
- **Recalling the past/anticipating the future:** Getting information about how the participant has struggled with the subject in the past and how they foresee the future without a change in their situation.
- **Opinions/points of view/attitude and projections:** Detect potential biases on the participant, but also understand their motivations, obstacles and pain points further.
- **Talking about problems and pain points:** Expanding on the participant's main obstacles in the subject matter.
- **Wishes:** Try to get an idea of what they want to have/use if everything is possible.

PHASE 1: INTRODUCTION

- Tell me a bit about yourself. What you study/work on.
- Would you consider yourself a techy person?
- Do you participate in collaborative projects often?

PHASE 2: EXPERIENCE WITH PKM

- What exactly is your experience with Personal Knowledge Management? When did you discover this concept?
- How has PKM impacted your life?
- What method/platform do you use and for what?
- You said (alone or with friends), can you expand on this?

PHASE 3: MAPPING

- What sources do you take information from for your knowledge base?
- Do you have ways to distinguish between sources of information once you have merged them in your knowledge base?
- Do/did you often use content from friends/peers and add it to your personal knowledge base?

PHASE 4: ACQUIRING/CAPTURING/CREATING

- What methods do/did you use to capture information in your knowledge base? Do you manually take notes or do you instead copy over resources as-is?
- Did time play an important role in the capture of content? Was there a time bound to it?
- Do you use resources or templates from other users of your platform to structure your content?

PHASE 5: PACKAGING

- Can you tell me roughly how you structure your information inside your knowledge base?
- If you worked with peers, did you notice fundamental differences in the way you preferred to structure information versus their way of doing it? If yes, were these differences irreconcilable?
- (If they share with other people) Do you perform deliberate changes to how you structure information if you know that you're gonna share it with others?

PHASE 6: STORING

- Did you use more than one device to access this knowledge base?
- Do you store your knowledge locally or in the cloud?

PHASE 7: PROBLEMS

- In the initial survey you said _____. Can you elaborate on that? Why does that represent a problem for you?
- In the survey you also mentioned that you (Share/don't share) content through the platform. Elaborate on that. How was the process? What stopped you from doing so?

PHASE 8: EXPECTATIONS

- You said that (response to alone/with peers question).
    - If alone - What has stopped you in the past from sharing your content with others?
    - If in company - Next question.
- What three factors would a Knowledge Management Platform have to have to get you to share your content with other users?

A.2 Qualitative Survey

A.2.1 Median results of the Quantitative Survey

	KMP Researcher	KMP Student	NonKMP Researcher	NonKMP Student	SD
Uses for KMPs					
For maintaining a Personal Knowledge Base	5	7	-	-	1.41
As a Reference Manager for research	7	5	-	-	1.41
To annotate on PDFs	5	5	-	-	0.00
To share useful academic resources with others	6	6	-	-	0.00
Self-perception towards PKM					
"The digital platforms I use make me more efficient."	5	7	6	5	0.96
"I consider myself an Early Adopter when it comes to tech."	5	6	4.5	5	0.63
"I've tried to get people on these (Knowledge Management) platforms but I've encountered some resistance from them."	5	5	-	-	0.00
"I still use other non-PKM tools as part of my digital workflow."	5	6	-	-	0.71
"I believe not a lot of people know about Personal Knowledge Management. There is an overall lack of awareness of the concept."	5	6	-	-	0.71
"I have sometimes felt like the digital methods I have used to collaborate with peers have been responsible for a decrease in productivity of the whole team." (Not necessarily referring to Knowledge Management platforms)	5	2	3	4	1.29
Views on collaboration					
"I'm not sure that Personal Knowledge Platforms will ever become the norm among university students. There needs to be a cultural shift for this to happen."	5	4	-	-	0.71
"My team members are usually very adamant about what digital tools to use when we work in a project. It is very hard to change their mind."	5	3	4	4	0.82
"I'm satisfied with the level of collaboration among peers in my academic environment."	5	5	5	5	0.00
"I find it very annoying when I'm working with a group and I have to adapt my work structure to what the group leader wants."	5	5	4	5	0.50
"If I made a platform for students to collaborate in, I would add a way to track how much everyone has collaborated. I am not okay with "leeches" getting credit and good grades for not doing anything."	5	5	6	5	0.50
Collaboration Details/Methods					
"I still use analog methods in my normal studying workflow." (Note-taking with pen and paper, printing and solving past exams, printing papers for annotation...)	5	5	5	5	0.00
"I often just volunteer to create the collaborative folders and documents for our project team, because this way I'm not confused about where to find all the files later."	5	5	4	5	0.50
"I have to export content from (my app of choice) and send it to my peers. I never share directly from the platform."	5	6	4	4	0.96
"There is not much collaboration in my study. The only occasion where I've collaborated with peers has been for group projects."	5	3	3	5	1.15
"There are a lot of steps in collaboration that take too much time. Some people still use email for communicating and it's so frustrating."	5	4	3	4	0.82
Pains					
"There is never enough information about the structure of information in collaboration projects. I spend half of my time looking for files instead of working."	5	5	2.5	4.5	1.19
"I've had problems with 'autosave' in the past. Sometimes it doesn't work or it doesn't save my last work."	5	4	4	5	0.58
"I don't like sharing stuff directly from (my Knowledge Management tool of choice). I'm too lazy to have to walk the other user through how the tool works, so I just export or screenshot."	5	5	-	-	0.00
"It's always such a pain to have to share the documents or folders with different people and have to manage the permissions everyone gets. I don't want to have to keep track of that."	5	4	3.5	5	0.75
"My friend/research/project group doesn't really want to change tools. I've shown them my (Knowledge Management Tool) and they like it, but they haven't started using it."	5	4	-	-	0.71
Favorite Functions					
"A good collaboration platform would need some sort of moderation. A person who does quality control and can insure the quality of the content."	5	6	4	5	0.82
"Simultaneous edition (multiple people being able to work at the same time on the same document) is something that I value greatly in a group project."	6	6	6.5	5	0.63
"I'm always looking for platforms that allow me to share content in a simple and fast way that is also nice for the ones I'm sharing to."	5	6	5	5.5	0.48
"In Knowledge Management platforms, Linked References are a function I like and I use actively."	5	7	-	-	1.41
"I've struggled with copying and pasting and the text format getting all jumbled up. I would love an option to copy or export text without formatting."	5	6	6	5	0.58
"I'd like a system that tracks how much everyone has contributed in a group project."	6	5	5	5	0.50

Table A.1: Median scores for the different quadrants in the quantitative survey questions. Scores range from 1 (Complete disagreement) to 7 (Complete agreement). Empty fields represent non-KMP users not having to respond to KMP-related statements.